

Workshop Manual

Sterndrive Transom Shield

AC

2(2)

Sterndrive

SX-M, SX-MTD

DP-SM, DP-SMTD, DP-SMTD1

Transom Shield

SX-M, SX-MLT, SX-MACLT,
SX-MHP, SX-MDA, SX-MDB

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Safety Warnings

Before working on any part of a *Volvo Penta* sterndrive, read the section called Safety at the end of this manual.

Introduction

This service manual is divided into sections concerning various systems and assemblies. Refer to the Contents to locate the section covering the system or assembly requiring service. Each section title page has an additional listing that will describe the section's contents in more detail. Be sure to read the Safety Section at the end of this manual, and pay special attention to all safety warnings as they appear throughout the text. Since models are subject to change at any time, some photos may not depict actual product.

Good Service Practice

Service required for this product is generally one of three kinds:

- **Normal care and maintenance** - which includes putting a new stern drive into operation, storing engines, lubrication, and care under special operating conditions such as salt water and cold weather.
- **Operating malfunctions** - due to improper engine or drive mounting, propeller condition or size, boat condition, or the malfunction of some part of the engine. This includes engine servicing procedures to keep the engine in prime operating condition.
- **Complete disassembly and overhaul** - such as major service or rebuilding a unit.

It is important to determine before disassembly just what the trouble is and how to correct it quickly, with minimum expense to the owner.

When repairing an assembly, the most reliable way to ensure a good job is to do a complete overhaul on that assembly, rather than just to replace the bad part. Wear not readily apparent on other parts could cause a malfunction soon after the repair job. Repair kits and seal kits contain all the parts needed to ensure a complete repair, to eliminate guesswork, and to save time.

Repair time can also be minimized by the use of special tools. *Volvo Penta* Special Tools are designed to perform service procedures unique to the product that cannot be completed using tools from other sources. They also speed repair work to help achieve service flat rate times. In some cases, the use of substitute tools can damage the part.

Note! Do not operate engine out of water even momentarily. If operated in test tank, use proper test wheel. Failure to do so can damage water pump, overheat engine, or allow excessive engine RPM.

Preparation for Service

Proper preparation is extremely helpful for efficient service work. A clean work area at the start of each job will minimize tools and parts becoming misplaced. Clean an engine that is excessively dirty before work starts. Cleaning will occasionally uncover trouble sources. Obtain tools, instruments and parts needed for the job before work is started. Interrupting a job to locate special tools or repair kits is a needless delay.

Use proper lifting and handling equipment. **Working on stern drives without proper equipment can cause damage and personal injury.**

Always use clean fresh fuel when testing engines. Troubles can often be traced to the use of old or dirty fuel.

- Service Policy** It is a policy to provide dealers with service knowledge so they can give professional service demanded by today's consumer. The *Volvo Penta* Training Centers, frequent mailing of Service Bulletins, Letters and Promotions, Special Tools and this Service Manual represent our continuing efforts to assist dealers in giving consumers the best and most prompt service possible. If a service question does not appear to be answered in this manual, you are invited to write to the *Volvo Penta* Service Department for additional help. Always be sure to give complete information, including engine model number and serial number.
- Be sure that you are familiar with the warranty statement supplied with the product. If you have any questions, write the *Volvo Penta* Service Department. If other than genuine *Volvo Penta* replacement components or parts are used, subsequent warranty claims involving that engine may be refused.
- When a brand-name product or specific tool is called for, another item may be used. However, the substitute must have equivalent characteristics, including type, strength, and material. You must determine if incorrect substitution could result in product malfunction and personal injury to anyone. To avoid hazards, equivalent products which are used must meet all current U.S. Coast Guard Safety Regulations and ABYC standards.
- Replacement Parts** **When replacement parts are required, always use genuine *Volvo Penta* parts, or parts with equivalent characteristics, including type, strength, and material. Failure to do so may result in product malfunction and possible injury to the operator and/or passengers.**
- Parts Catalogs** Parts Catalogs contain exploded views showing the correct assembly of all parts, as well as a complete listing of the parts for replacement. These catalogs are helpful as a reference during disassembly and reassembly, and are available from ***Volvo Penta Parts***.
- Special Service Tools** Special service tools have been specially designed to simplify some of the disassembly and assembly operations. These tools are illustrated in this Service Manual, in many cases in actual use. All *Volvo Penta* special tools can be ordered from ***Volvo Penta Parts***. Individual purchasers of Service Manuals must order Special Tools through an authorized dealer.

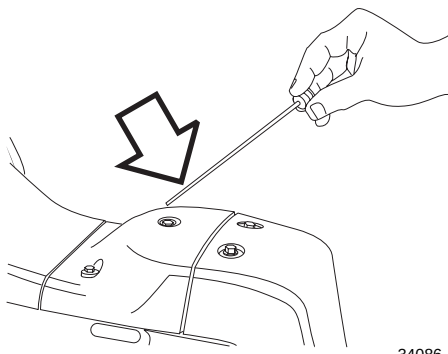
Product References, Illustrations & Specifications

Volvo Penta reserves the right to make changes at anytime, without notice, in specifications and models and also to discontinue models. The right is also reserved to change any specifications or parts at any time without incurring any obligation to equip same on models manufactured prior to date of such change. All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of printing. The right is reserved to make changes at anytime without notice.

All photographs and illustrations used in this manual may not depict actual models or equipment, but are intended as representative views for reference only. The continuing accuracy of this manual cannot be guaranteed.

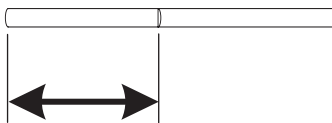
Sterndrive Lubrication - SX Models

Adding Lubricant to Sterndrive



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Occasionally check oil level in sterndrive. Screw dipstick fully into hole. Remove and read oil level in reference to mark on dipstick. If oil level is low, add oil through dipstick opening.



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Add only enough lubricant to bring the oil level to the proper level somewhere in the range on the dipstick.

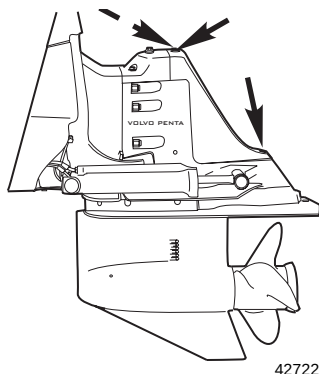
Sterndrive Oil Capacity

Change Lubricant Every 100 Hours or Once Each season Use Volvo Penta Synthetic Gearcase Lubricant or Mobilube 1 SHC Fully Synthetic SAE 75W-90 gear lubricant	
All SX Models	71oz. (2100 cc)

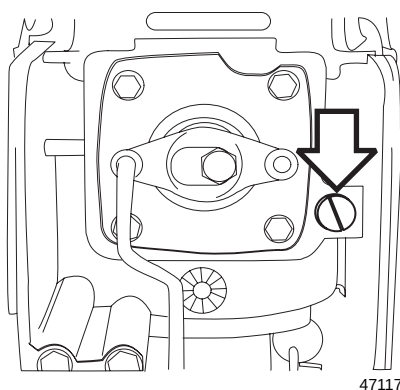
Draining and Filling Sterndrive

When a complete change of lubricant is required in the sterndrive, proceed as follows:

- 1. Place sterndrive in the run (full down) position. Place a 4 quart drain pan under lower gear case skeg to catch oil.
- 2. Remove oil drain plug (port side of lower gear case) and oil level dipstick (top of sterndrive). Removing dipstick vents drive to improve oil draining. Allow oil to drain completely.



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3. Remove three screws securing the shift link access cover to access the oil level plug. Fill sterndrive with *Volvo Penta Synthetic Gearcase Lubricant* SAE 75W-90 through oil drain plug hole. Fill slowly to purge air.

4. Sterndrive is properly filled when the oil level appears at the oil level plug hole. When filled to the proper level, install oil level dipstick and the oil level plug first to prevent excessive oil loss, then the oil drain plug. Tighten oil level gauge, plug, and drain plug finger tight.

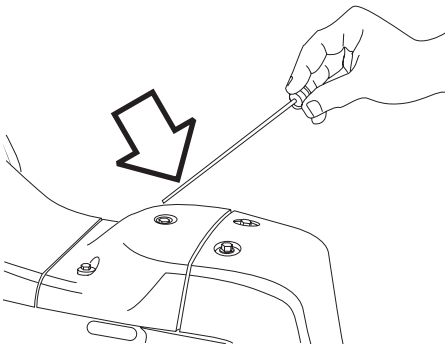
Note! Filling sterndrive too quickly may form air pockets that will cause an inaccurate oil level reading. Running the sterndrive with improper oil level will result in immediate internal damage.

5. Check oil level with dipstick. Oil level must appear on the blade of the dipstick. Add oil if required, through the dipstick hole **See “Adding Lubricant to Sterndrive” on page 8.**
6. Tighten drain plug to 60-84 in. lb. (6,8-9,5 N.m). Tighten oil level dipstick to 48-72 in. lb. (5,4-8,1 N.m)
7. Install shift link access cover and tighten screws to 108-132 in. lb. (12,2-14,9 N.m).

If lubricant has been completely changed, oil level must be rechecked after unit has been run and trapped air purged. Improper oil level will result in serious internal sterndrive damage. Add make-up oil through dipstick opening to bring oil up to proper level.

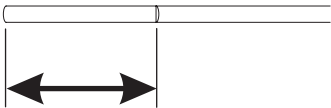
Sterndrive Lubrication - DP-S Models

Adding Lubricant to Sterndrive



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Occasionally check oil level in sterndrive. Screw dipstick fully into hole. Remove and read oil level in reference to mark on dipstick. If oil level is low, add oil through dipstick opening.



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Add only enough lubricant to bring the oil level to the proper level somewhere in the range on the dipstick.

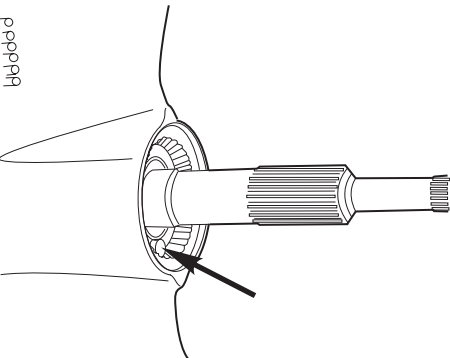
Sterndrive Oil Capacity

Change Lubricant Every 100 Hours or Once Each Season Use <i>Volvo Penta Synthetic Gearcase Lubricant</i> or <i>Mobilube 1 SHC Fully Synthetic SAE 75W-90</i> gear lubricant	
All DP-S Models	81 oz. (2400ml)

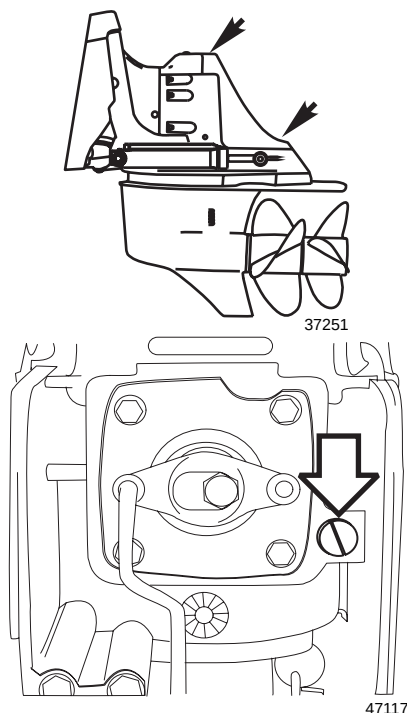
Draining and Filling Sterndrive

When a complete change of lubricant is required in the sterndrive, proceed as follows:

1. Remove both propellers **See “Propeller Removal and Installation - DP-S Models” on page 263.**
2. Place sterndrive in the run (full down) position. Place a 4 quart drain pan under lower gear case skeg to catch oil.
3. Remove the oil drain plug (inside lower gear case) and the oil level dipstick (top of sterndrive). Removing dipstick vents drive to improve oil draining. Allow oil to drain completely.



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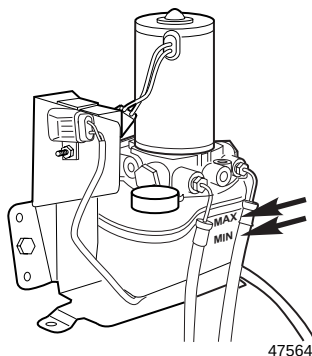
- Remove three screws securing the shift link access cover to access the oil level plug. Fill sterndrive with *Volvo Penta Synthetic Gear Lubricant SAE 75W-90* through oil drain plug hole. Fill slowly to purge air. Sterndrive is properly filled when the oil level appears at the oil level plug hole. When filled to the proper level, install oil level dipstick and the oil level plug first to prevent excessive oil loss, then the oil drain plug. Tighten oil level gauge, plug, and drain plug finger tight.

Note! Filling sterndrive too quickly may form air pockets that will cause an inaccurate oil level reading. Running the sterndrive with improper oil level will result in immediate internal damage.

- Check oil level with dipstick. Oil level must appear on the blade of the dipstick. Add oil if required, through the dip stick hole See "Adding Lubricant to Sterndrive" on page 8.
- Tighten drain screw to 60-84 in. lb. (6,8-9,5 N.m). Tighten oil level dipstick and gauge plug to 48-72 in. lb. (5,4-8,1 N.m)
- Install shift link access cover and tighten screws to 108-132 in. lb. (12,2-14,9 N.m).

If lubricant has been completely changed, oil level must be rechecked after unit has been run and trapped air purged. Improper oil level will result in serious internal sterndrive damage. Add make-up oil through dipstick opening to bring oil up to proper level.

Power Trim/Tilt-Fluid Level



The trim/tilt assembly contains an electric motor, hydraulic pump, and reservoir. At the beginning of each boating season, check the fluid level in the reservoir as follows:

- Level should be between the "MIN" and "MAX" marks on the reservoir.
- If necessary, add *Volvo Penta Power Trim/Tilt and Steering Fluid Power Trim/Tilt and Power Steering Fluid*. Replace the cap and tighten securely.

When checking fluid level, inspect the trim/tilt unit for leaks and proper operation. If service is necessary, see your authorized dealer.

Off -Season Storage Preparations - All Models

- Change** Sterndrive Lubricant:
Drain and refill with fresh *Volvo Penta Synthetic Gearcase Lubricant SAE 75W-90*.
- Lubricate** Gimbal Bearing and universal joint splines and inspect bellows for wear or leaks:
Refer to information elsewhere in this section.
- Inspect** Sterndrive Water Pickup Screens for Obstructions.
See **Engine** Service Manual for additional engine off-season storage procedures.

Painting

- Remove all marine growth.

2. Remove all loose paint and corrosion by sanding or sandblasting. If sandblasting, use an aluminum oxide blasting media with a particulate size of 0.008-0.028 in. (0.2-0.7 mm).
3. Remove all trace of grease and wash with hot water and detergent. Roughen all painted surfaces with medium *3M Scotchbrite™* pad. Rinse thoroughly with water.
4. Treat any bare aluminum with chromate conversion coating. Clean the entire area with an acid cleaner that does not contain fluoride, such as *DuPont® 5717*. Scrub the surface with *3M Scotchbrite™* pad until it is completely “wetted” with no beads of water.

Note! Fluoride in a cleaner causes a “smut” (dark discoloration on silicon-alloy aluminum castings), and paint will not stick to “smut”. If this happens, sand the surface and start over using a different acid cleaner.

Note! Do not use steel wool. Small pieces of steel wool become embedded in the aluminum and will cause severe corrosion.

5. Rinse thoroughly with water. The area must appear “wetted” or the surface is not clean, and paint will not adhere.
6. While the surface is still wet from rinsing, treat all bare aluminum with *DuPont® 226S* chromate conversion solution. Brush the chromate solution as required for 2 to 5 minutes to prevent it from drying on the surface. Rinse the surface thoroughly with water and allow to air dry. Follow the label instructions exactly.
 - If the chromate is allowed to dry anywhere on the bare aluminum surface, chromic acid salts will form which will prevent paint adhesion and promote corrosion. Sand the surface to bare metal.
 - It is best to let the part air dry, but if you must wipe the surface to speed up drying, use lint free wipes not treated with anything that may contaminate the surface. Do not scrub the surface, wipe very lightly.
 - Do not blow dry with shop air unless it is completely free of dirt, oil, and water.
 - Do not heat the part above 150°F, before painting.
 - Do not touch the treated surface with bare hands before painting.
 - The part should be primed soon after it dries, or at least within 24 hours.
7. Where the prime coat is thin or where the surface is unpainted, prime with *Volvo Penta Primer* or *PPG® Super Koropon* epoxy primer. Do not apply primer over hard finish coat. Primer solvents must be allowed time to evaporate and the primer must harden before applying the finish coat. Allow 8 to 12 hours drying time.
8. Apply finish coat. The parts catalogs list numbers for finishing products.

Preparation for Boating After Storage

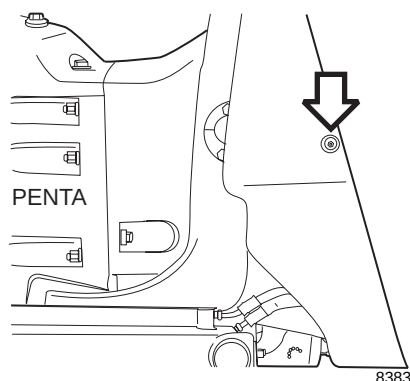
See **Engine** Service Manual for Engine specific information.

Gimbal Bearing and Inspect Universal Joint bellow.

The gimbal bearing and universal joint splines **MUST** be lubricated each year. Lubricate the gimbal bearing and universal joint splines inspect

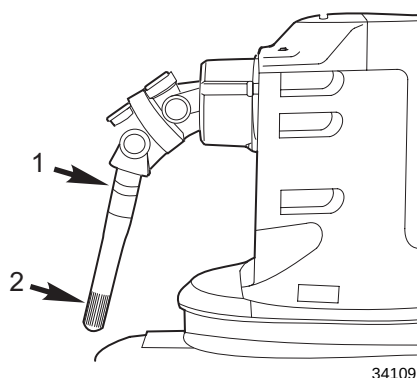
the bellows when preparing your boat for off-season storage. This requires the removal of the sterndrive.

Note! Failure to lubricate the gimbal bearing, universal joint shaft splines and inspect the bellows each year will result in damage to the transom shield and sterndrive.



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The gimbal bearing is lubricated by a grease fitting located on the starboard side of the gimbal housing. *Volvo Penta* recommends that lubrication of the gimbal bearing be done with sterndrive removed. This will allow observation of old grease as it's being replaced by the new. If there is evidence of water, the bearing should be inspected and replaced. Lubricate gimbal bearing with *EP/Wheel Bearing Grease* or equivalent. Apply grease until all old grease has been removed and new grease appears.



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The sterndrive must be removed to lubricate the universal joint shaft splines. When the sterndrive is removed, wipe old grease and dirt off universal joint shaft splines, then thoroughly clean splines before applying new grease. The universal joint shaft splines (2) must be lubricated with *Moly Lube*® grease or equivalent, and light oil applied to the shaft O-rings(1). The bellows should be checked for damage and deterioration. Replace if necessary. Engine alignment must also be checked. See "Sterndrive Removal" on page 227

Recommendations For Antifouling Paints

⚠ All antifouling paints that prevent marine growth are poisonous and may harm our marine environment. The legislation concerning antifouling paints has changed in many countries and others have announced coming changes in their legislation.

In general, the legislation is or will be considerable more restrictive as far as the allowed leakage of the active ingredients in the paint to the water is concerned. Several countries have put into practice (or will put into practice) a more restrictive legislation for pleasure boats that for commercial boats and vessels. The reason is that pleasure boat harbors often are situated in shallow waters, which are spawning grounds for fish. Contrary to commercial boats, pleasure boats spend most of their time tied up in the harbor, which adds to the impact on the environment in these waters.

Since the protection of the environment is in the best interests of all concerned, it is important to minimize the use of antifouling paints. As far as smaller boats are concerned, trailer boats which can be taken out of the water, we recommend *Teflon* type paint only, combined with cleaning a few times during the season. This procedure can prove somewhat impractical as far as larger boats are concerned and therefore antifouling paints might have to be used. However, always take care to find out the valid legislation in the area where you intend to use the boat prior to starting the treatment of the boat. The legislation can also provide rules as to the boat weight or overall length. Always follow these directions.

Note! It may be completely forbidden to use antifouling paints on pleasure boats in some instances (e.g. in fresh water).

Painting The Stern Drive With Anti-fouling Paint

Clean the stern drive carefully. Degrease and flush thoroughly with water. Sand the surface with a water-abrasive paper (grit size 200-240). Make sure not to sand through the original paint of the stern drive. Damage to drive paint must be carefully repaired with primer and paint. Pure metal must be cleaned prior to the application of primer. Make sure to let the primer and paint harden in accordance with the manufacturer's instructions. Mask the hull around the transom bracket and spots on the sterndrive which are not to be painted.

Note! Do not paint the anodes.

Important!

Make sure that you have a good contact between the anodes and the transom bracket or sterndrive. Prior to launching the boat, the anodes must be cleaned (activated) with emery cloth in order to remove the oxide layer. Never use a steel brush when cleaning. The steel brush reduces the galvanic protection. The engine, transom bracket, and sterndrive must never be in contact with other metal components below the water line. Electrical equipment (such as charging equipment, navigational aids, VHF radios, etc.) must never be grounded to the engine, transom bracket or sterndrive.

Paints For Stern drives

See the parts catalog for the model in question for the part numbers for paint for the engine, transom bracket or sterndrive. Paint may be obtained from **Volvo Penta Parts**.

Painting The Hull With Antifouling Paint

Always follow the manufacturer's instructions. When making the purchase, make sure that you receive the correct product meeting the legislation prevailing in the area where you are going to use the boat. The product must contain the correct properties for the boat hull type. Aluminum hulls often require an initial treatment with an etching primer. Use a pure copper bases antifouling paint containing copper tiocyanate, not copper oxide. Tin based (TBT paints) are no longer allowed. Make sure to prepare the hull in accordance with the directions of the paint manufacturer.



Caution!

Leave a 1 in. (25 mm) strip unpainted around the transom bracket. Contact with bottom paint may cause sever corrosion of the transom and sterndrive assembly.

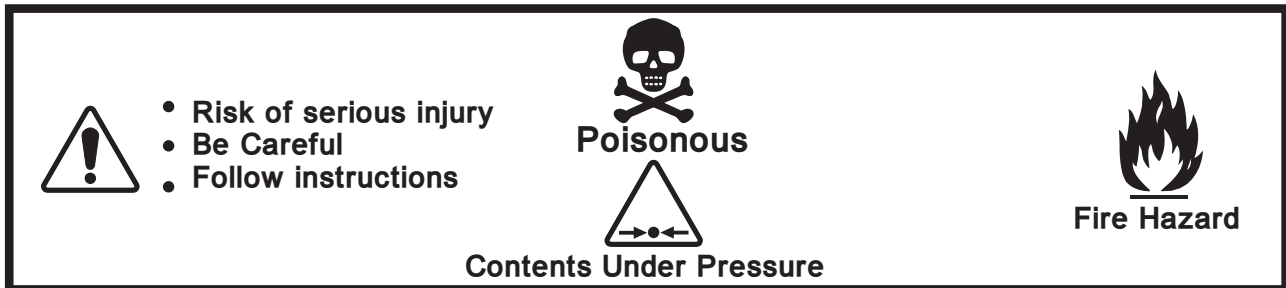
Metric Conversion Chart

LINEAR			FUEL ECONOMY AND FUEL CONSUMPTION		
inches	X 25.4	= millimeters (mm)	miles/gal	X 0.42514	= kilo metres/liter (km/l)
feet	X 0.3048	= metres (m)	Note: 235.2/(mi/gal) = liters/100 km 235.2/(liters/100 km) = mi/gal		
yards	X 0.9144	= metres (m)	LIGHT		
miles	X 1.6093	= kilo metres (km)	footcandles	X 10.76	= lumens/metre ² (lm/m ²)
inches	X 2.54	= centimeters (cm)	PRESSURE OR STRESS		
AREA			inches HG (60°F)	X 3.377	= kilo pascals (kPa)
inches ²	X 645.16	= millimetres ² (mm ²)	pounds/sq in	X 6.895	= kilo pascals (kPa)
inches ²	X 6.452	= centimetres ² (cm ²)	inches H ₂ O (60°F)	X 0.2488	= kilo pascals (kPa)
feet ²	X 0.0929	= metres ² (m ²)	bars	X 100	= kilo pascals (kPa)
yards ²	X 0.8361	= metres ² (m ²)	pounds/sq ft	X 47.88	= pascals (Pa)
acres	X 0.4047	= hectares (10 ⁴ m ²) (ha)	POWER		
miles ²	X 2.590	= kilometres ² (km ²)	horsepower	X 0.746	= kilowatts (kW)
VOLUME			ft-lbf/min	X 0.0226	= watts (W)
inches ³	X 16387	= millimetres ³ (mm ³)	TEMPERATURE		
inches ³	X 16.387	= centimetres ³ (cm ³)	°Celsius = 0.556 X (°F -32)		
inches ³	X 0.01639	= liters (l)	°Fahrenheit = (1.8 X °C) +32		
quarts	X 0.94635	= liters (l)	TORQUE		
gallons	X 3.7854	= liters (l)	pound-inches	X 0.11299	= newton-metres (N.m)
feet ³	X 28.317	= liters (l)	pound-feet	X 1.3558	= newton-metres (N.m)
feet ³	X 0.02832	= metres ³ (m ³)	VELOCITY		
fluid oz	X 29.57	= milliliters (ml)	miles/hour	X 1.6093	= kilo metres/hour (km/h)
yards ³	X 0.7646	= metres ³ (m ³)	feet/sec	X 0.3048	= metres/sec (m/s)
MASS			kilo metres/hr	X 0.27778	= metres/sec (m/s)
ounces (av)	X 28.35	= grams (g)	miles/hour	X 0.4470	= metres/sec (m/s)
pounds (av)	X 0.4536	= kilograms (kg)			
tons (2000 lb)	X 907.18	= kilograms (kg)			
tons (2000 lb)	X 0.90718	= metric tons (t)			
FORCE					
ounces - f (av)	X 0.278	= newtons (N)			
pounds - f (av)	X 4.448	= newtons (N)			
kilograms - f	X 9.807	= newtons (N)			
ACCELERATION					
feet/sec ²	X 0.3048	= metres/sec ² (m/S ²)			
inches/sec ²	X 0.0254	= metres/sec ² (m/S ²)			
ENERGY OR WORK					
foot-pounds	X 1.3558	= joules (j)			
calories	X 4.187	= joules (j)			
Btu	X 1055	= joules (j)			
watt-hours	X 3500	= joules (j)			
kilowatt - hrs	X 3.600	= megajoules (MJ)			

LINEAR SYMBOLS

Certain symbols or combinations of symbols may appear on your stern drive or on their accessories. It is very important that you understand their meaning or purpose. If any symbol is not clearly understood, see your authorized dealer.

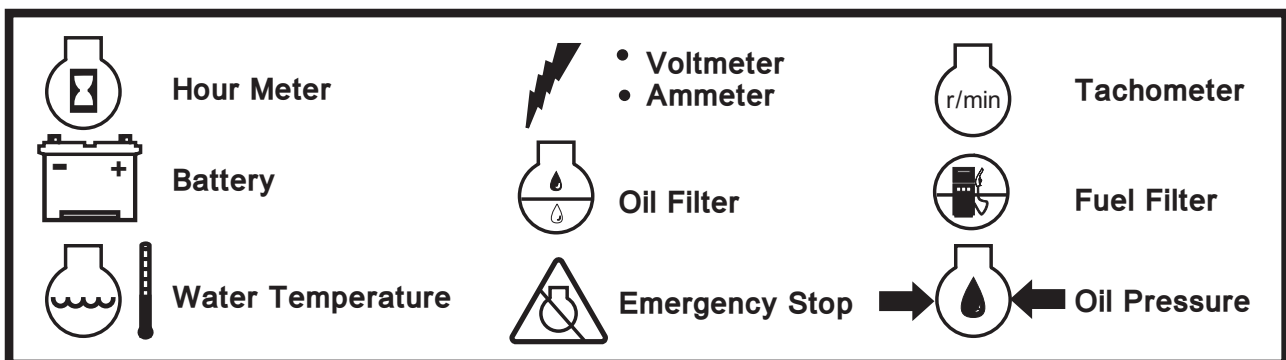
“Safety Warning” Symbols



“Position Indicator” Symbols



“Condition” Symbols



“Instructional” Symbols



Table 1: Drill Size Conversion Chart

SHOWING MILLIMETER SIZES, FRACTIONAL AND DECIMAL INCH SIZES AND NUMBER DRILL SIZES														
Milli-Meter	Dec. Equiv.	Fract-Num-ber	Milli-Meter	Dec. Equiv.	Fract-Num-ber	Milli-Meter	Dec. Equiv.	Fract-Num-ber	Milli-Meter	Dec. Equiv.	Fract-Num-ber	Milli-Meter	Dec. Equiv.	Fract-Num-ber
.1	.0039		1.75	.0689		...	.1570	22	6.8	.2677		10.72	.4219	27/64
.15	.0059		...	.0700	50	4.0	.1575		6.9	.2716		11.0	.4330	
.2	.0079		1.8	.0709		...	.1590	21	...	.2720	I	11.11	.4375	7/16
.25	.0098		1.85	.0728		...	.1610	20	...	.2756		11.5	.4528	
.3	.0118		...	.0730	49	4.1	.1614		...	.2770	J	11.51	.4531	29/64
...	.0135	80	1.9	.0748		4.2	.1654		7.1	.2795		11.91	.4687	15/32
.35	.0138		...	.0760	48	...	.1660	19	...	.2811	K	12.0	.4724	
...	.0415	79	1.95	.0767		4.25	.1673		7.14	.2812	9/32	12.30	.4843	31/64
.39	.0156	1/64	1.98	.0781	5/64	...	.1693		7.2	.2835		12.5	.4921	
.4	.0157		...	.0785	47	...	.1695	18	7.25	.2854		12.7	.5000	1/2
...	.0160	78	2.0	.0787		4.37	.1719	11/64	...	.2874		13.0	.5118	
.45	.0177		2.05	.0807		...	.1730	17	...	.2900	L	13.10	.5156	33/64
...	.0180	77	...	.0810	46	4.4	.1732		7.4	.2913		13.49	.5312	17/32
.5	.0197		...	.0820	45	...	.1770	16	...	.2950	M	13.5	.5315	
...	.0200	76	2.1	.0827		4.5	.1771		7.5	.2953		13.89	.5469	35/64
...	.0210	75	2.15	.0846		...	.1800	15	7.54	.2968	19/64	14.0	.5512	
.55	.0217		...	.0860	44	4.6	.1811		7.6	.2992		14.29	.5624	9/16
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.6	.0236		2.25	.0855		4.7	.1850	13	7.7	.3031		14.68	.5781	37/64
...	.0240	73	...	.0890	43	4.75	.1870		7.75	.3051		15.0	.5906	
...	.0250	72	2.3	.0905		4.76	.1875	3/16	...	.3071		15.08	.5937	19/32
.65	.0256		2.35	.0925		4.8	.1890	12	7.9	.3110		15.48	.6094	39/64
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.7	.0276		2.4	.0945		...	.1935	10	...	.3160	O	16.0	.6299	
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.9	.0354		...	.1065	36	5.25	.2067		8.6	.3386		18.26	.7187	23/32
...	.0360	64	2.75	.1082		5.3	.2086		...	.3390	R	18.5	.7283	
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...	.0390	61	...	.1110	34	5.5	.2165		8.8	.3465		19.45	.7656	49/64
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...	.0410	59	...	.1160	32	...	.2210	2	9.0	.3543		20.0	.7874	
1.05	.0413		3.0	.1181		5.7	.2244		...	.3580	T	20.24	.7969	51/64
...	.0420	58	...	.1200	31	5.75	.2263		9.1	.3583		20.5	.8071	
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...	.0465	56	3.25	.1279		...	.2340	A	9.3	.3661		21.43	.8437	27/32
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1.59	.0625	1/16	...	.1495	25	6.6	.2598		10.0	.3937		24.21	.9531	61/64
1.6	.0629		3.8	.1496		...	.2610	G	...	.3970	X	24.5	.9646	
...	.0635	52	...	.1520	24	6.7	.2638		...	.4040	Y	24.61	.9687	31/32
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1.7	.0669		...	.1540	23	6.75	.2657		...	.4130	Z	25.03	.9844	63/64
...	.0670	51	3.97	.1562	5/32	...	.2660	H	10.5	.4134		25.4	1.0000	1

Periodic Maintenance Chart

Service Point	Every 25 Hours or as Specified	Every 50 Hours or as Specified	Recommendations
Gimbal Bearing		Lubricate seasonally. NOTE: Do not Use a power operated grease gun.	Use <i>EP/Wheel Bearing Grease</i> or equivalent.
Trim/Tilt Pump		Seasonally check fluid level in reservoir. Check for leaks and proper operation.	Use <i>Volvo Penta Power Trim/Tilt and Steering Fluid</i> .
Sterndrive		Drain and refill every 100 hours or once a year. Check level occasionally during boating season.	Use <i>Volvo Penta Synthetic Gear Lubricant SAE 75W-90</i> .
Universal Joint Shaft Splines		Lubricate seasonally.	Use <i>Moly Lube®</i> or equivalent.

Transom Shield Assembly - SX-M

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Safety Warnings Before working on any part of the transom shield assembly, read the section called Safety at the end of this manual.

When replacement parts are required, use genuine *Volvo Penta* or parts with equivalent characteristics including type, strength and material. Failure to do so may result in product malfunction and possible injury to the operator and/or passengers.

Some screw holes have special *Heli-Coil* inserts that provide a thread-locking feature. Do not clean *Heli-Coil* holes with a thread tap. This will damage the *Heli-Coil* inserts and force their replacement.

Special Tools

Tool Name	Volvo P/N	Panel Location
Drive Handle	3850609-3	A
Driver	3854356-7	E
Insert Tool	3854349-2	B
Installer	3854359-1	E
Installer	3854360-9	E
Installer	-	K*
Remover/ Installer	3854355-9	E
Remover/ Installer	3845358-3	E
Retaining Ring Pliers	3850608-5	B
Rod	3854351-8	C
Socket Removal Tool	3854350-0	B
Tiller Arm Puller	3845361-7	K

* Same panel position as obsoleted Installer, P/N 912279

Owatonna Service Tools

OTC No. 1176 Slide Hammer

Order From:

OTC Division of SPX Corporation

655 Eisenhower Drive

Owatonna, Minnesota 55060 USA

Toll free order line: 1-800-533-5338 Or 1-800-533-0492

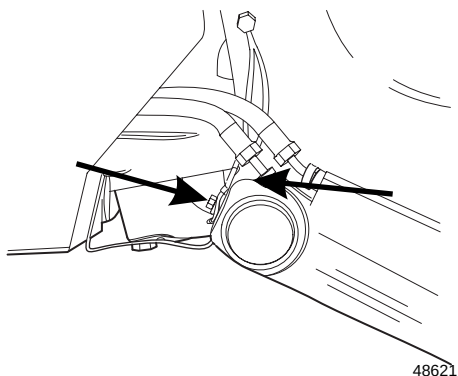
<http://www.otctools.com>

Remove Sterndrive

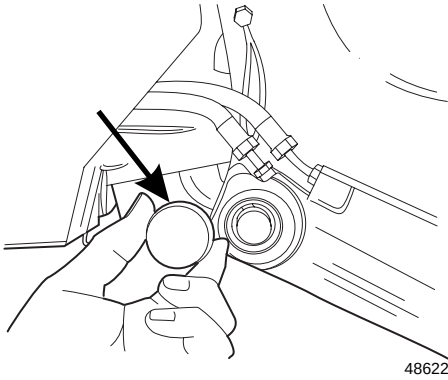
Remove the Sterndrive see Sterndrive Removal on page 227. If the complete transom shield assembly is being rebuilt or replaced, remove engine following procedure in the ***Engine and Sterndrive Installation Manual***.

Trim/Tilt Cylinder Removal

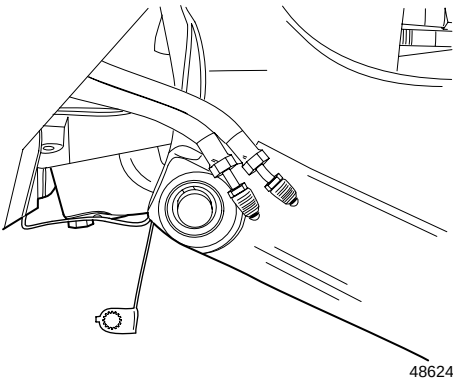
1. Remove screw and ground wire from the front of the cylinder.



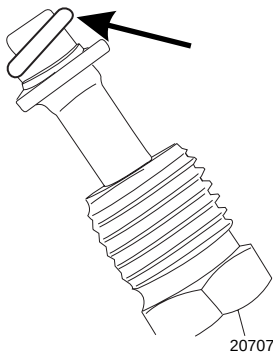
2. Carefully remove pivot pin cap.



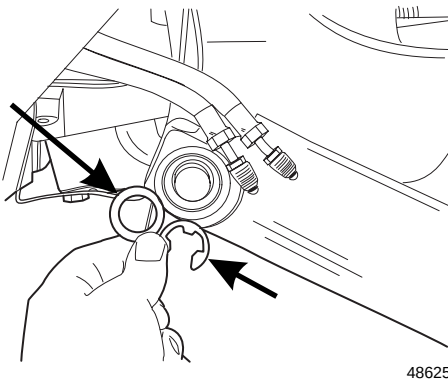
3. **Wear safety glasses:** Cover fittings with a shop cloth, and disconnect trim/tilt lines.



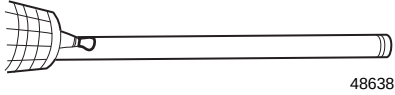
4. Remove and discard trim/tilt line O-rings.



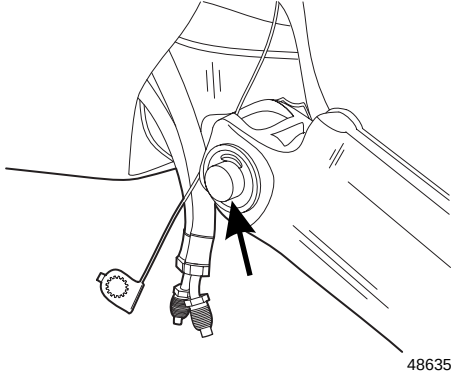
5. **Wear safety glasses:** Remove pivot pin E-clip and flat washer. Pull pivot pin out of cylinder, gimbal ring, and cylinder on opposite side. Remove bushing from gimbal ring and replace if necessary. Remove cylinder and set aside to drain.
6. Remove the ground wire and hydraulic lines from the remaining cylinder.



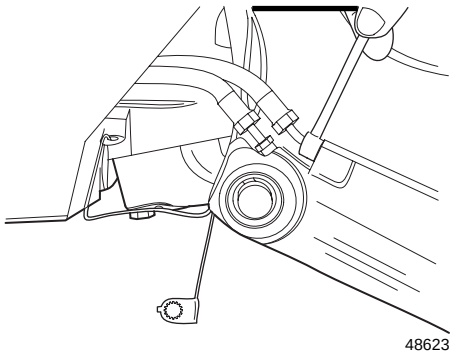
Trim/Tilt Cylinder Installation



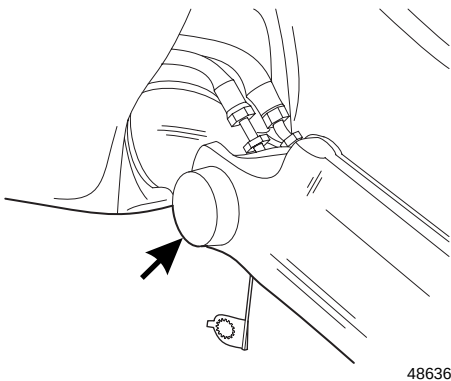
1. Remove the remaining E-clip and washer from the pivot pin. the pivot pin, then coat it with *Volvo Penta Grease* P/N 828250. Replace the gimbal ring's bushings if they're damaged, then slide the pivot pin through the cylinders and gimbal ring.



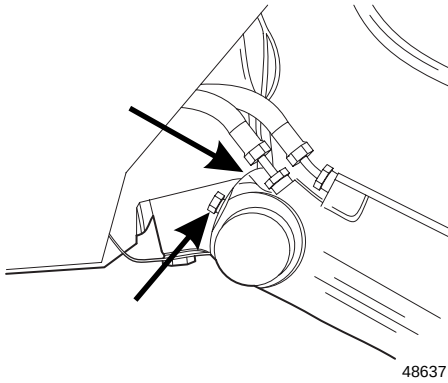
2. Center the pivot pin. Install both washers and E-clips.



3. Place a new O-ring on the trim/tilt cylinder line fittings and attach lines to cylinder. Tighten line fittings to 84-108 in. lb. (9,5-12,2 N.m).



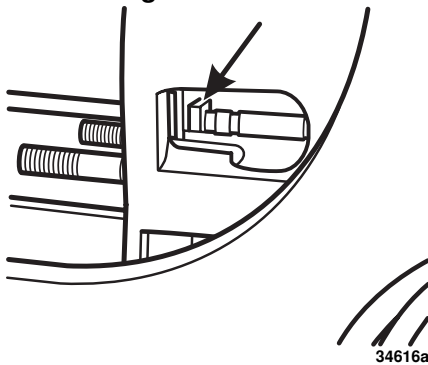
4. Install pivot pin caps.



5. Attach ground wires to front of trim/tilt cylinders. Tighten screws securely.

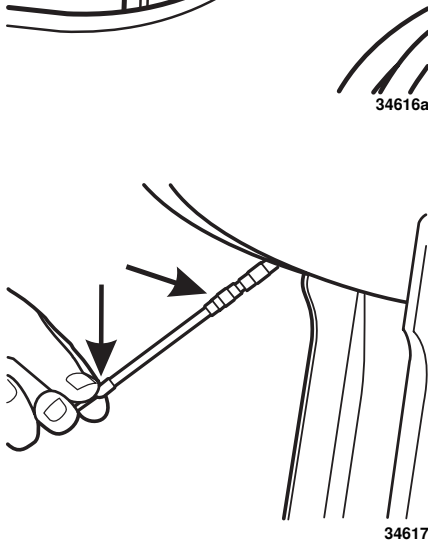
Note! To fill and bleed the trim cylinders and trim motor reservoir, see **Filling and Bleeding Dry System in Trim/Tilt Hydraulic System** section of this manual.

Pivot Housing Removal

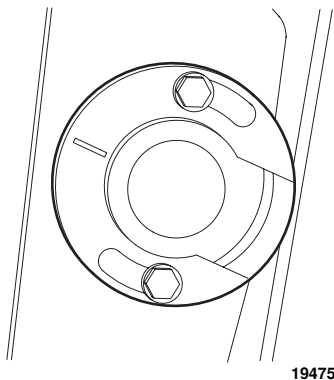


Remove the sterndrive following the procedure in **Sterndrive Removal and Installation** section in this manual.

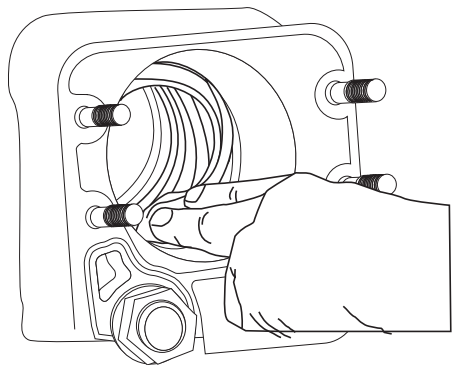
1. Turn Sterndrive to port. Loosen anchor clamp screw and slide clamp to starboard disengaging the remote control shift cable.



2. Remove shift cable from the pivot and gimbal housing. Remove the small and large seals. From inside of boat, pull shift cable out of the sleeve and connector assembly.

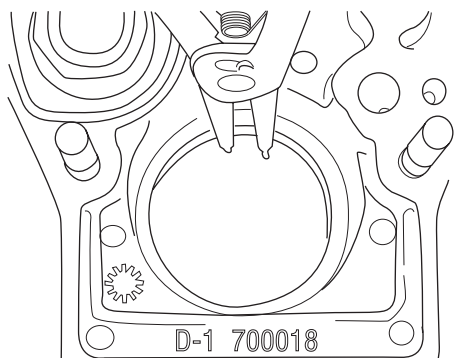


3. Turn the gimbal to port and remove the two screws holding the trim sender. Do not attempt to pull out the sender as its leads are secured to the transom shield.



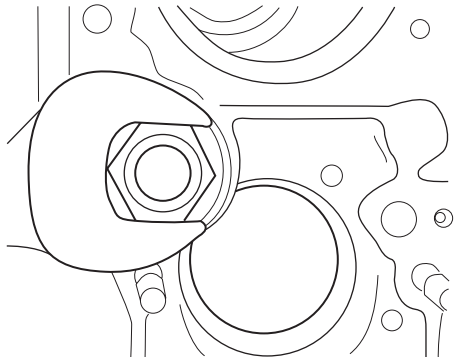
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4. Disengage the U-joint bellows from the lip of the pivot housing and push it inside.



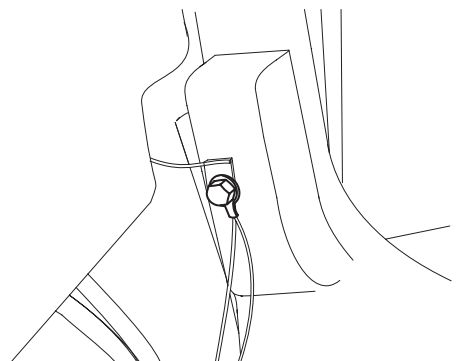
34531

5. **Wear safety glasses.** Use Retaining Ring Pliers, *Volvo Penta* P/N 3850608 to remove the retainer from inside of the exhaust boot, then push the boot inside the housing.



34768

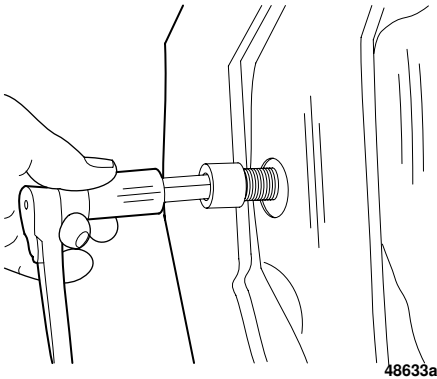
6. Unscrew the nut securing the water hose nipple, and push the nipple through the housing as far as possible.



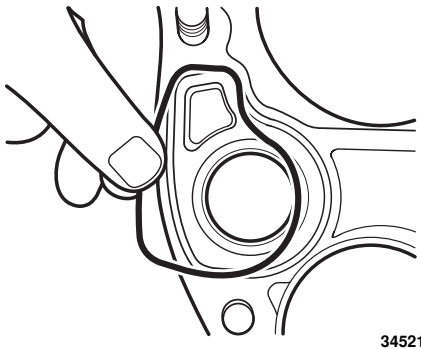
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7. Turn gimbal ring to the starboard. Remove screw and both ground straps.

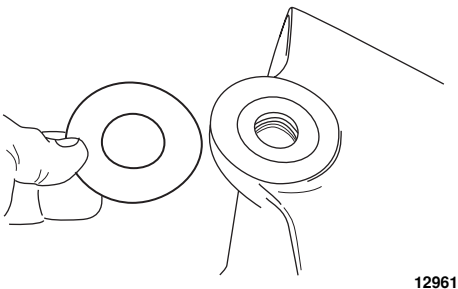
8. Use a 1/2 in. hex drive wrench or socket and remove both pivot pins.



Pivot Housing Disassembly



1. Remove and discard the cooling passage O-ring.



2. Inspect the nylon friction washer on the pivot bosses. Peel them off and discard them if they're damaged. Remove and inspect the thrust washer underneath.

Cleaning and Inspection

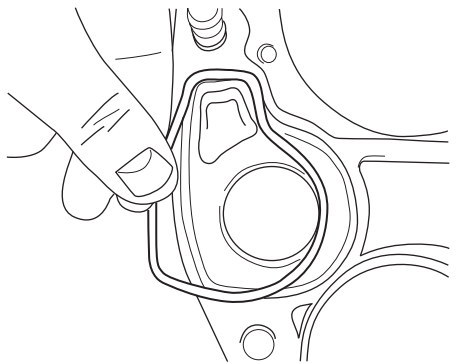
Clean housing in solvent and dry thoroughly. Remove sealer and/or adhesive from the cooling passage opening, U-joint bellows opening, and pivot bosses.

Note! Clean screw holes with solvent only. A thread tap would damage the *Heli-Coil* inserts and force their replacement.

- **O-ring Seal Groove** - Check for sharp edges that would prevent O-ring sealing water passage.
- **Mounting Studs** - Look for damaged threads and looseness.
- **Ground Wire** - Check wire ends for frayed or loose connections.

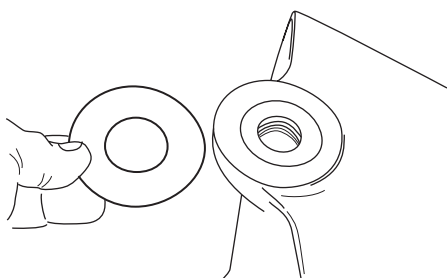
Repair or replace all suspect components.

Pivot Housing Assembly



34523

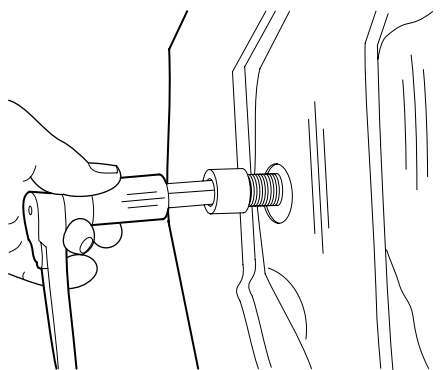
1. Apply 3M Adhesive sealant to the groove around the water passage, and install a new O-ring seal.



12961

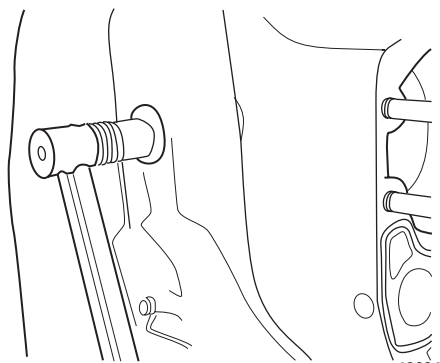
2. If the old pivot boss friction washers were removed, make sure a thrust washer coated with *Volvo Penta Grease P/N 828250* is installed in each pivot. Install two new friction washers and coat them with *Volvo Penta Grease P/N 828250*

Pivot Housing Installation



48633a

1. Position the pivot housing in the gimbal ring. Guide the water tube nipple through the housing, and position the bellows behind their respective openings.
2. Align one gimbal ring pivot pin hole with the hole in the pivot housing. Look inside to see if the thrust washer is still in position and not blocking the hole. Screw in the pivot pin until it seats, **but do not tighten** it at this time.

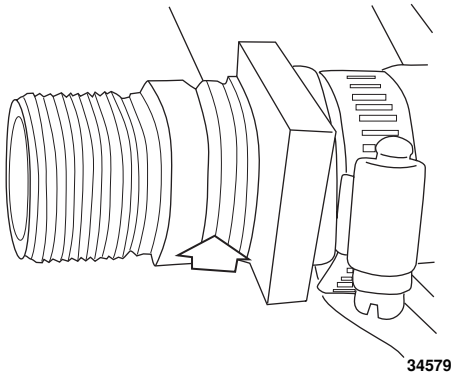


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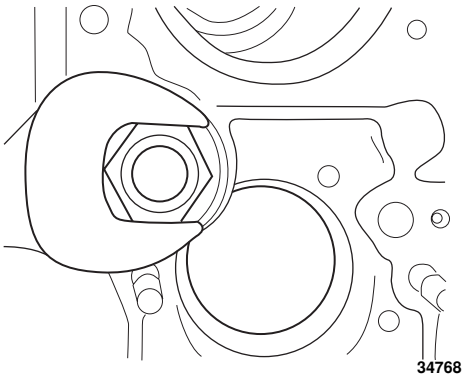
3. Align and install the other pivot pin. Tilt the housing up and down to see if it moves freely. Use a 1/2 in. hex socket and tighten the pivot screws to 105-120 ft. lb. (142-163 N.m).

Note! Hold pivot housing to keep housing from over rotating and damaging bellows and water hose while tightening pivot screws.

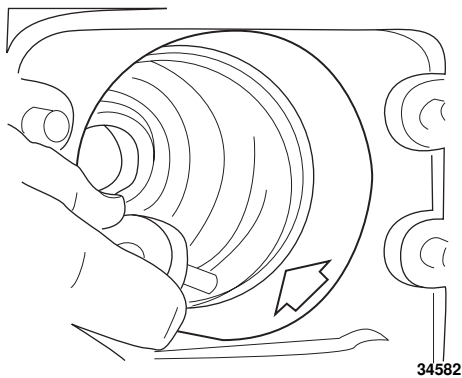
4. The drain hole in the nipple must face down when installed in the pivot housing.



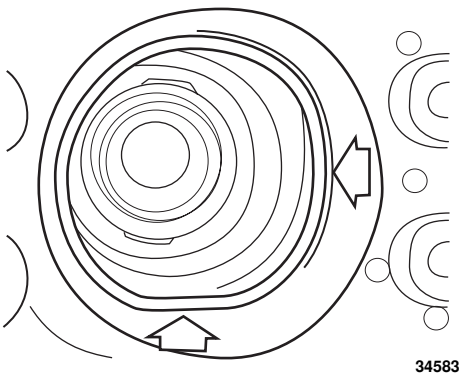
5. Pull the water tube through the pivot housing as far as it will go. Screw on the water nipple nut. If the nipple turns with the nut, or if the nipple end does not protrude through the nut when it's seated, then the square nipple collar is not located properly behind the housing. Loosen the nut and rotate the nipple to reposition it. Make sure the drain hole in the nipple faces down. Tighten the nut to 96-120 in. lb. (11-14 N.m).

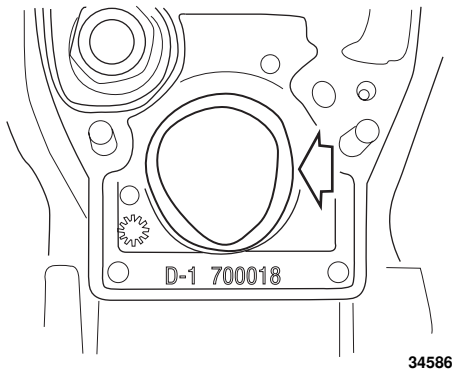


6. Apply *Volvo Penta Gasket Sealing Compound* around the complete inner V-shaped lip of the pivot housing, to seal the U-joint bellows against water entry.

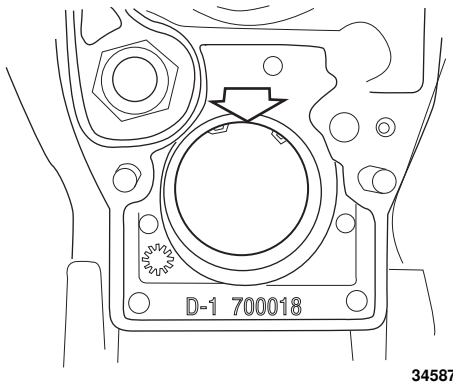


7. Pull the U-joint bellows through the opening and seat the lip in the groove. Bellows must seal the entire circular opening; any flat spot on the lip indicates the bellows has not engaged the V-groove.

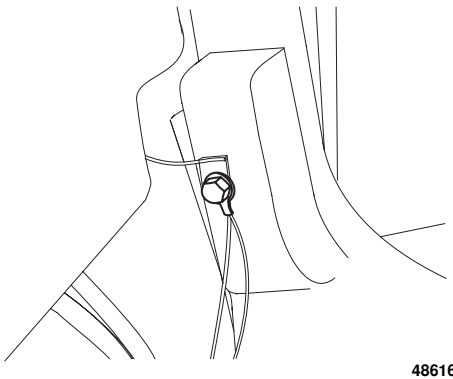




8. Pull top of exhaust bellows through the pivot housing. Tilt the pivot housing and push the bottom of exhaust bellows through the pivot housing seating the bellows channel around the lip of the pivot housing opening. Any flat spot on the bellows indicates the bellows has not engaged the lip.

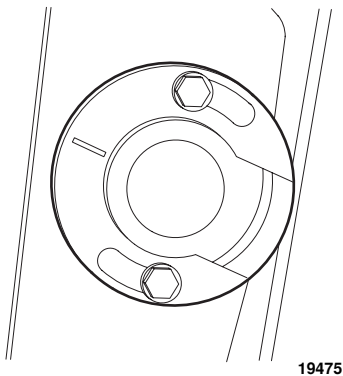


9. **Wear safety glasses.** Insert the retaining ring inside the bellows. Position the opening upward as shown for secure attachment.



10. Attach the ground wires with screw to the threaded hole on the port side of gimbal ring.
11. Install and adjust the trim, **see Trim Sender Adjustment on page 33.**

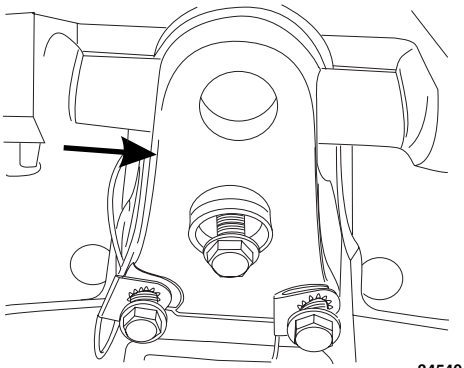
Gimbal Ring Removal



Remove trim/tilt cylinders and pivot housing following instructions elsewhere in this section.

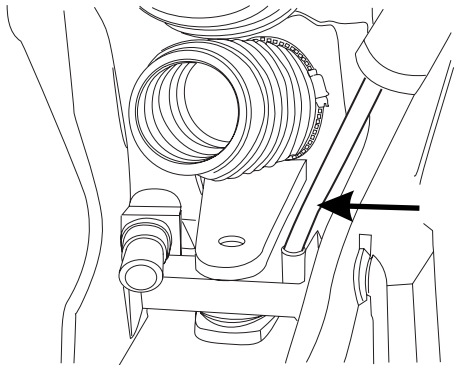
1. Turn the gimbal to port and remove the two screws holding the trim sender. Do not attempt to pull out the sender as its leads are secured to the transom shield.

2. Remove the three screws and lock washers holding the lower steering support bracket and pull the bracket off.



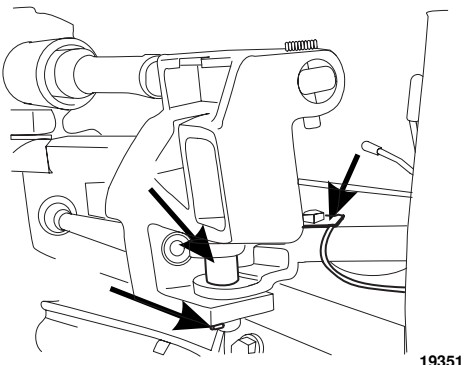
34540

3. If it's tight, use a drift punch and mallet to tap on alternating sides of the bracket until its free.



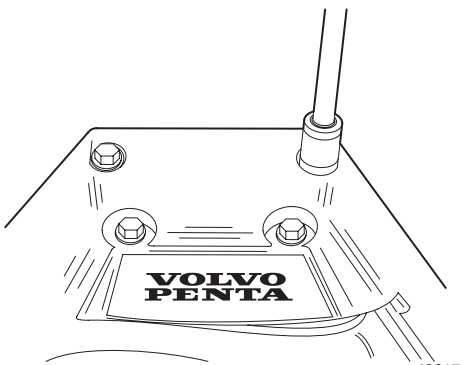
34482

4. Remove cotter pin and steering arm pin. Remove ground strap from steering arm.



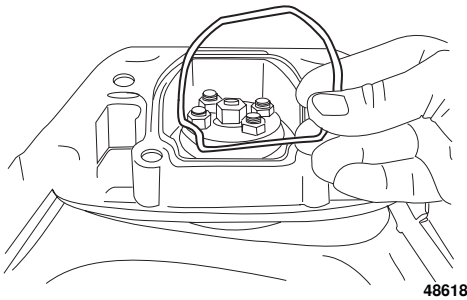
19351

5. Remove four screws and the gimbal housing cover.

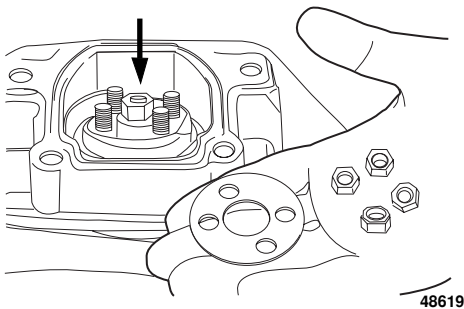


48617

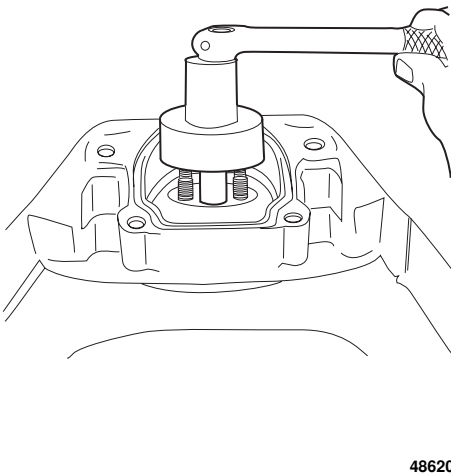
6. Remove and discard the sealing ring.



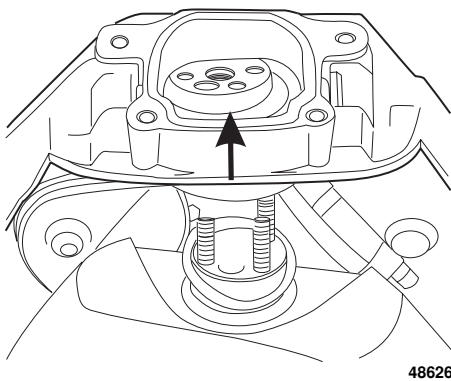
7. Remove the four locknuts and retaining plate from the top of the steering arm. Unscrew the center steering arm bolt.



8. Rest Tiller Arm Puller, *Volvo Penta* P/N 3854361, on top of the two alignment dowels inside the steering arm, and install the center bolt. Tighten the bolt to remove the steering arm. Be ready to catch the gimbal ring when the arm comes free.



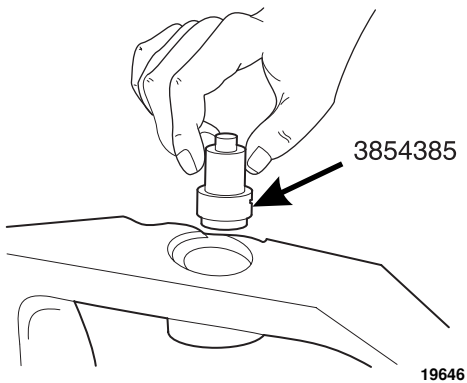
9. Remove the steering arm from inside the boat. Remove thrust washer from the gimbal housing.



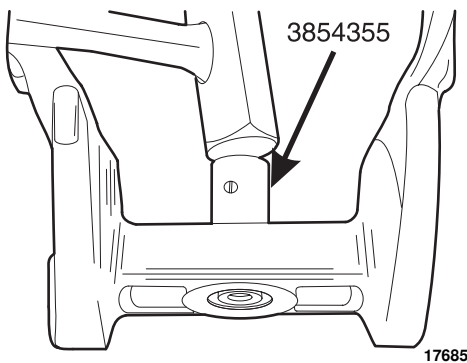
Gimbal Ring Disassembly

1. Remove and discard the O-ring around the upper steering post.

2. Face the large diameter end of Remover/Installer, *Volvo Penta P/N 3854385*, toward the gimbal ring. Insert the tool into either tilt bearing and drive it out. Remove the other tilt bearing in a similar manner.

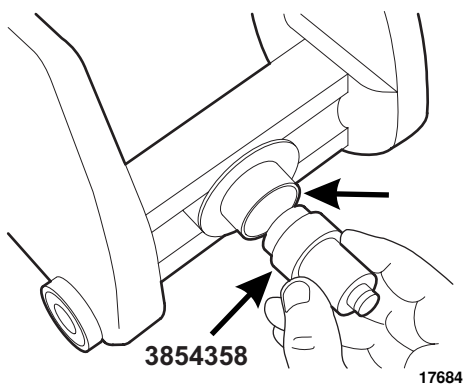


3. Insert small end of Remover/Installer, *Volvo Penta P/N 3854355* into bearing, and drive out bearing.

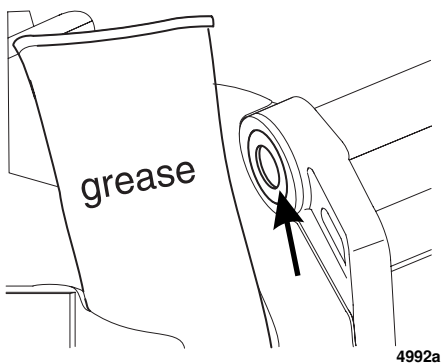


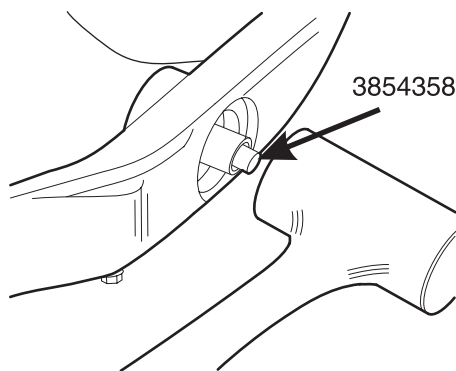
Gimbal Ring Assembly

1. Lightly oil the outside of a new lower pivot bearing and place it in the bore. Use Installer, *Volvo Penta P/N 3854358* to seat the bearing into the bottom of the gimbal ring.
2. Install two new trim/tilt nylon pivot pin bushings into the gimbal ring.



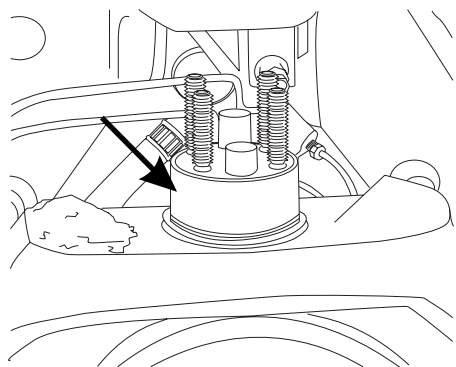
3. Apply *Volvo Penta Grease P/N 828250* to the inside of both trim/tilt nylon bushings.





19717a

4. Lightly oil the outside of two new tilt bearings. Insert a bearing into the gimbal ring from the outside. Insert the blunt end of Remover/Installer, *Volvo Penta* P/N 3854358 into bearing. Using a soft face hammer, seat bearing flush to 0.010 in. (0,254 mm) below inner surface of gimbal ring. Repeat procedure for installation of the other bearing.



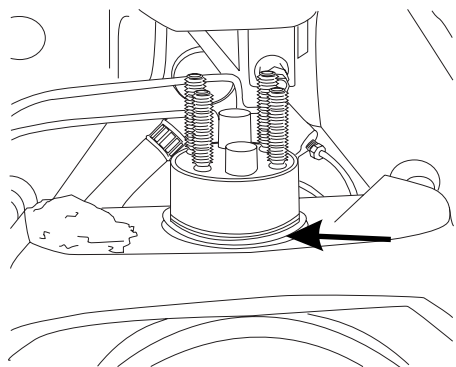
34511

5. If bushing around upper steering post is damaged, it can be removed by splitting it down one side with a sharp tool.

Note! When replacing steering post bushing, check upper bearing inside gimbal housing to see if it also needs replacement.

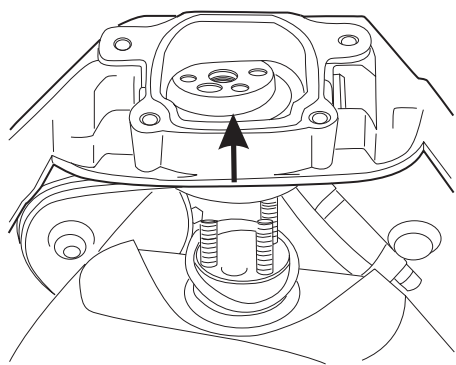
6. If upper steering post bushing was removed, lubricate inside diameter of a new bushing with *Volvo Penta Grease* P/N 828250 and place bushing on top of steering post. Install steering arm and center bolt. Tighten center bolt until bushing seats, then remove center bolt and steering arm.

Gimbal Ring Installation



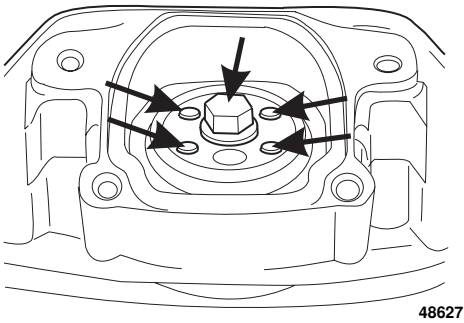
34511a

1. Coat a new O-ring with *Volvo Penta Grease* P/N 828250 and place it around the base of the upper steering post.



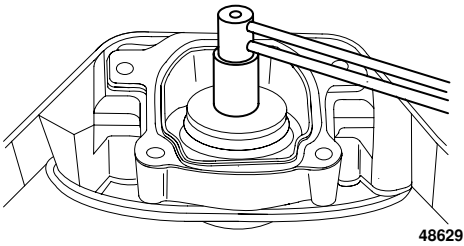
48626

2. Coat the thrust washer with *Volvo Penta Grease* P/N 828250 and set it over the upper pivot bearing inside the top of the gimbal housing. From inside of boat, position steering arm over the thrust washer.

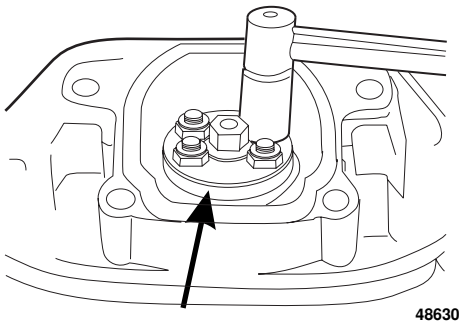


3. Guide gimbal ring steering post up engaging steering arm and install center bolt finger tight.

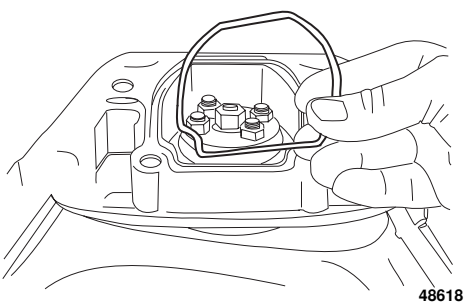
Note! When the gimbal ring is properly centered in the upper bearing, the gimbal studs must be flush or above the top of the steering arm when the bolt is finger tight. If the studs are not at the position described, the upper bearing will be damaged when the center bolt is tightened.



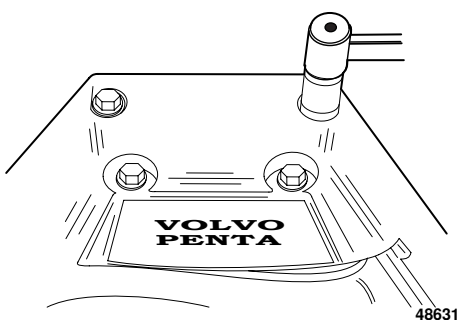
4. Tighten the center bolt to 65-72 ft. lb. (88-98 N.m).



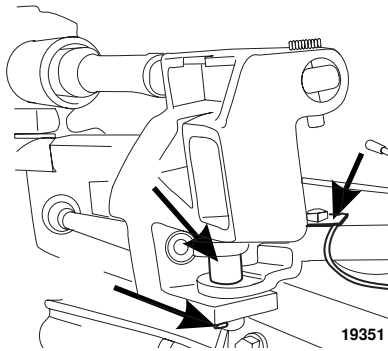
5. Place the washer on top of the steering arm. Install four new lock-nuts and tighten them to 13-15 ft. lb. (18-20 N.m).



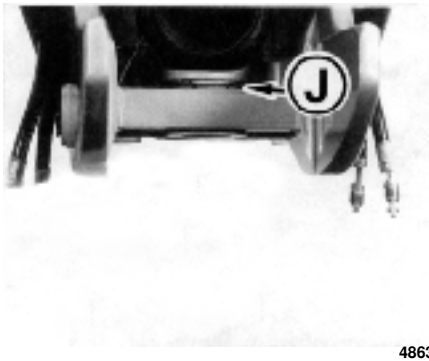
6. Apply 3M Adhesive to the groove around the steering cavity, and install a new sealing ring.



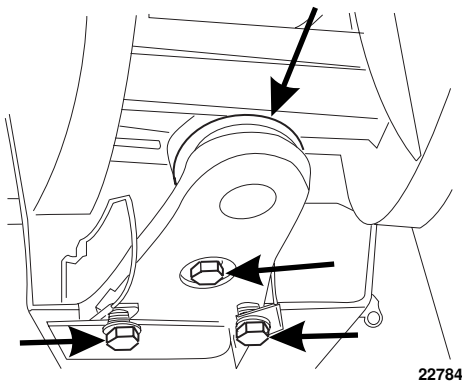
7. Set the gimbal housing cover in place. Install four mounting screws and tighten them to 60-84 in. lb. (7-9 N.m).



8. Attach ground wire to steering arm inside transom. Apply *Volvo Penta Grease P/N 828250* to large pin. Pull hydraulic arm assembly over steering arm. Align holes and install large pin from top of arm. Install cotter pin. Spread prongs of cotter pin to secure large pin.



9. Apply *Volvo Penta Grease P/N 828250* to the nylon thrust washer and lower pivot post. Slide nylon washer between gimbal ring and gimbal housing. Align pivot post hole of the gimbal ring, gimbal housing, and thrust washer, then slide pivot post assembly through the gimbal ring and gimbal housing until it is seated.



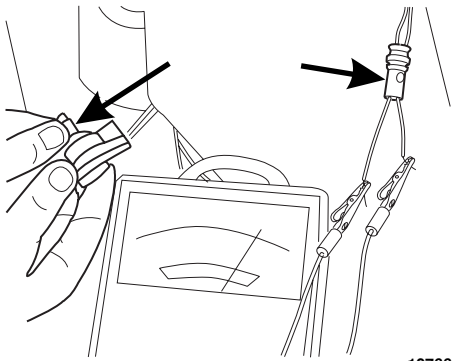
10. Install the lower steering support bracket. Seat it with a mallet if necessary. Apply upward pressure to gimbal ring and support bracket. Use lower thrust washers as a gauge to determine how many will fit space between upper surface of support bracket and lower surface of gimbal ring.

Note! The support bracket has a protruding lip on its upper surface where it fits over the pivot pin. When checking fit, washer insertion must be done at this point only, otherwise too many shims will be measured and installed. These washers will preload gimbal ring.

After determining number, add **one extra**, then install them in position. Use a minimum of one but no more than five washers to shim gimbal ring.

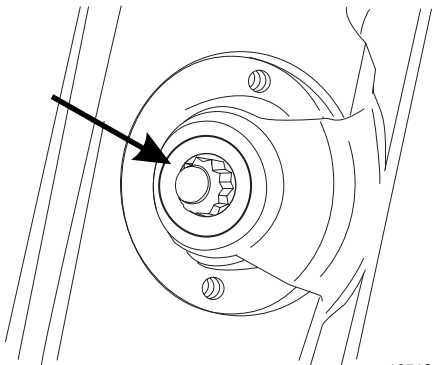
11. Attach the trim cylinder ground wires to the two forward screws, then install the lock washers. Screw in all three mounting screws and tighten them to 18-20 ft. lb. (24-27 N.m).
12. Install trim/tilt cylinders see Trim/Tilt Cylinder Installation on page 20 and pivot housing following instructions see Pivot Housing Installation on page 24.

Trim Sender Adjustment

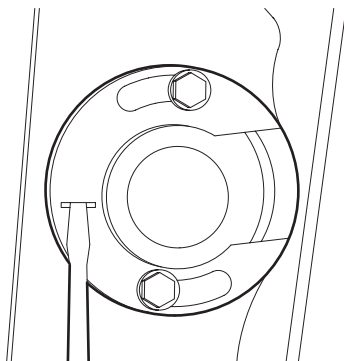


19766a

1. Connect an ohm meter to the sending unit connector. Turn the sending unit control nut until the meter reads 11 ± 1 ohm.

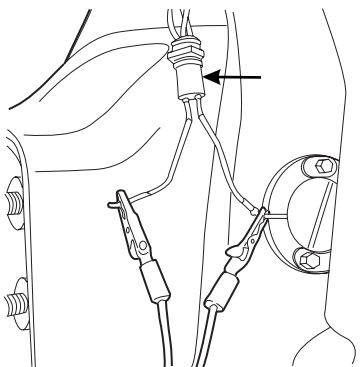


19513a



19514

2. With lower edge of pivot housing pushed in towards the gimbal housing, insert sending unit control nut into pivot bolt head. Install two trim sender mounting screws finger tight.



42584

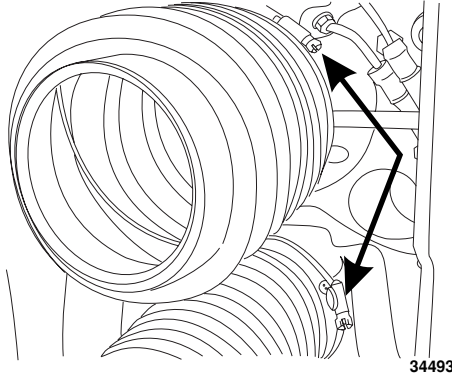
3. With the pivot housing pushed in towards the gimbal housing, check adjustment of sending unit between pins "A" and "C" of the sending unit connector. Rotate sending unit to obtain a 11 ± 1 ohm reading on the meter, then tighten mounting screws to 18-24 in. lb. (2,0-2,7 N.m).

Gimbal Housing Disassembly

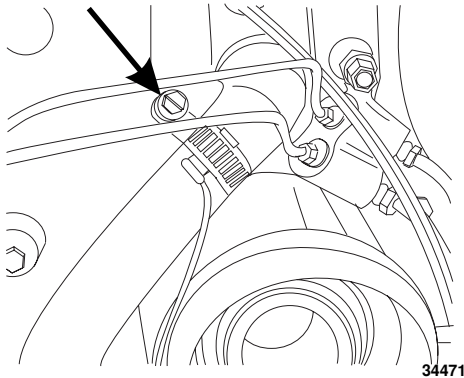
Remove trim/tilt cylinders see Trim/Tilt Cylinder Removal on page 18, pivot housing see Pivot Housing Removal on page 21, and gimbal ring see Gimbal Ring Removal on page 26.

Water Hose and Bellows Removal

1. Unscrew clamps and pull off the U-joint and exhaust bellows.



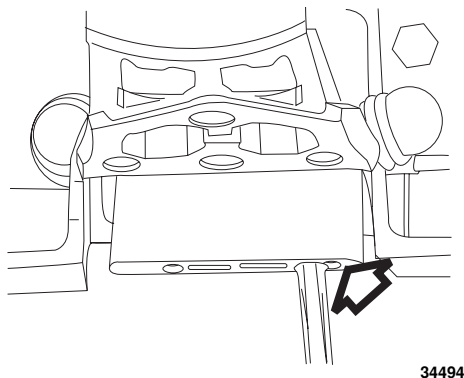
2. Loosen clamp on upper end of water inlet hose and remove hose from water tube.



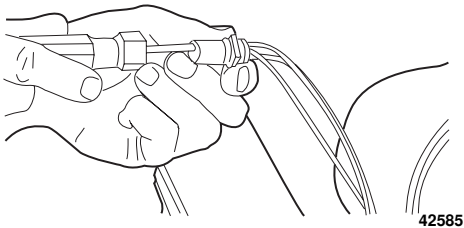
Anode Replacement

Note! The sacrificial zinc anode need not be removed unless it's 2/3 deteriorated and needs to be replaced.

1. Remove the two screws, lock washers, flat washers, and the anode.
2. Clean the mounting surface, then install the new anode and the attaching hardware. Tighten the screws to 12-14 ft. lb. (16-19 N.m).



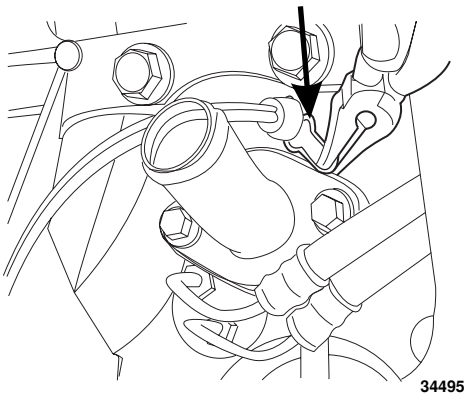
Trim Sender Removal



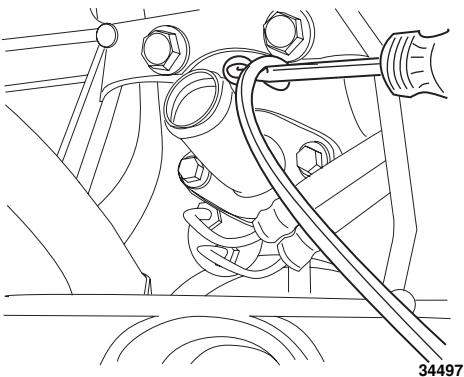
1. Disconnect rubber connector at wiring harness on engine. Record the position of the sending unit wires before removing. Use Socket Removal Tool, *Volvo Penta* P/N 3854350 to push terminals out of rubber plug.

Note! The use of alcohol or equivalent will make socket installation into the rubber plug easier.

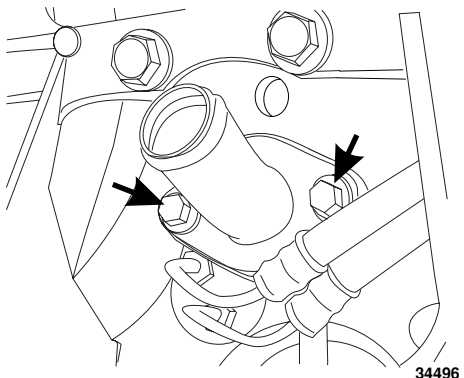
2. Remove the retaining clip from the grommet.



3. Push the grommet out with a screwdriver. Pull the wires through the hole, cut tie straps securing wires to the trim/tilt lines, and remove the trim sender.



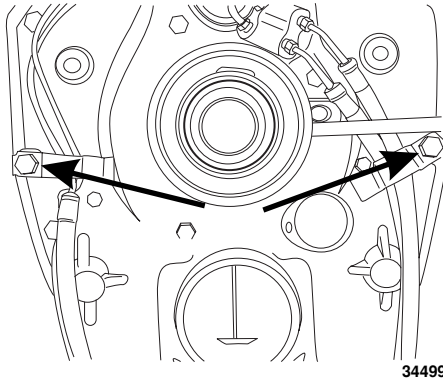
Water Tube Removal



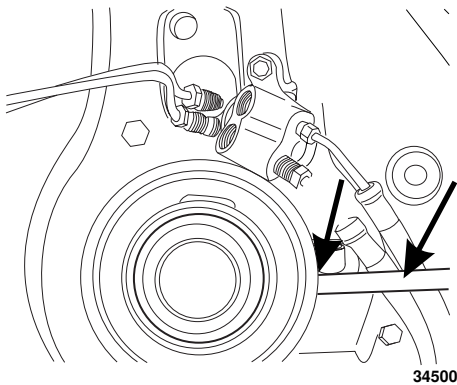
1. Remove the two screws from the water tube retainer. Pull the water tube and grommet out of the gimbal housing. If the grommet sticks, go to the outside of the transom and push it through.
2. If the grommet needs to be replaced, slide it off the water tube. It can be reused if undamaged.

Hydraulic Lines and Manifold Removal

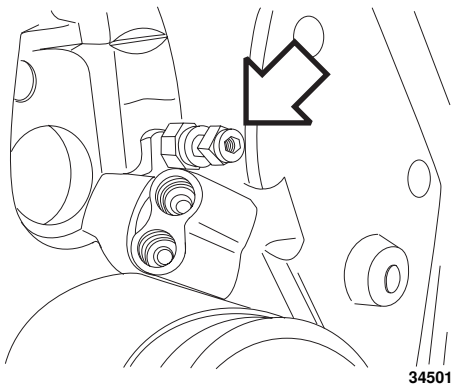
1. Remove the two clamps that secure the lines to each side of the gimbal housing.



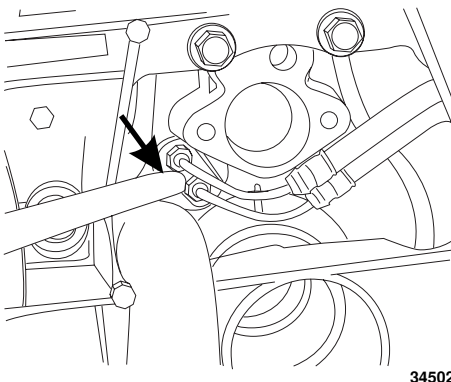
2. Unscrew all four lines and remove them from the manifold. Remove and discard the fitting O-rings. Removal of the grease extension tube may make the servicing of the starboard side lines easier. Clamp a vise grip pliers close to the bearing bore and rotate the tube to loosen it. Pry against the plier head to force the tube out of the housing.

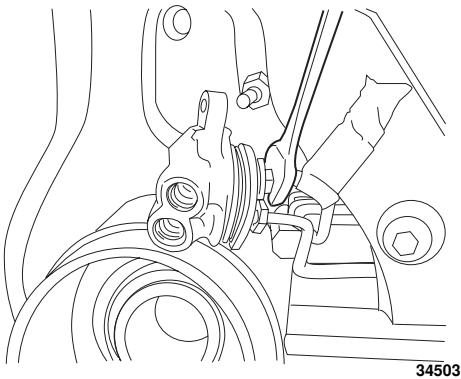


3. Remove the locknut and washer that attach the manifold old to the housing.



4. Since the manifold is sealed by an O-ring, use a small drift to drive it out of the housing from the inside of the boat.



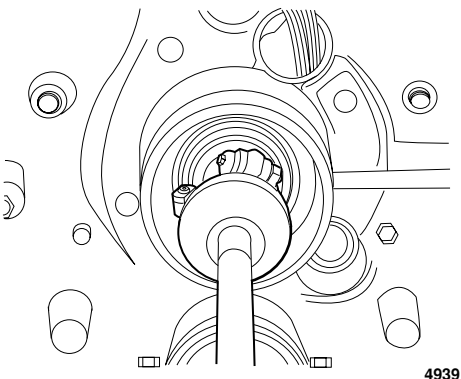


34503

Steering, Gimbal Bearing and Seal Removal

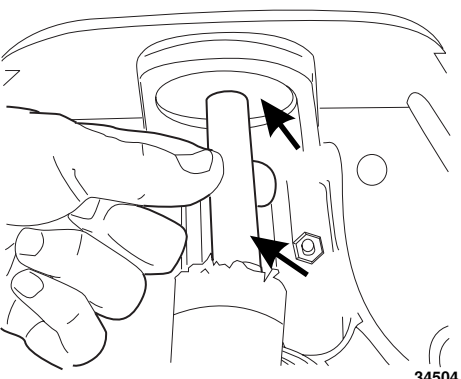
5. Pull the manifold and lines through the hole as far as possible. Tag one line for reference and note their direction of routing.
6. Unscrew both lines, then discard the fitting O-rings. Remove the manifold O-ring and discard it.

Note! Do not remove the gimbal bearing or upper steering bearing unless they need to be replaced. Removal of the gimbal bearing and seal do not require disassembly of the transom shield. Access can be gained by going through the U-joint bellows on an assembled transom shield.



4939

1. Use a three-jaw puller such as *Owatonna Tool*, P/N 1176, to pull out the gimbal housing bearing. Spread the tool jaws between the bearing and inner seal, and expand them tightly behind the bearing. Remove and discard the bearing.
2. Pull the inner seal out in a similar manner and discard it.



34504

3. Remove the thrust washer from around the top of the upper steering bearing. Use Installer, *Volvo Penta* P/N 3854360 and Driver, *Volvo Penta* P/N 3854356 to remove the bearing. Insert the driver into the installer and position the tool underneath the bearing as shown. Drive the bearing up and out of the bracket.

Gimbal Housing Cleaning and Inspection

Clean grease and sealer from bearing cavity, seal seat, and manifold cavity. Check inner bore diameter for scoring or discoloration that indicates a spinning bearing.

- **Pivot Bearing** - Inspect *Teflon* surface for wear or corrosion.
- **Gimbal Bearing** - Rollers must spin freely and hub must pivot in all directions; inner diameter must be free of corrosion.
- **Hydraulic Manifold** - O-ring groove must be free of nicks and burrs; all fluid passages must be clear.

- **Hydraulic Lines** - must be clear and fittings undamaged.
- **Grease Fitting and Tube** - must be unobstructed.
- **Mounting Studs** - must be tight and have no thread damage.
- **Seal Grooves** - Check for corrosion, burrs and damaged edges.
- **Anode** - Check amount of deterioration.

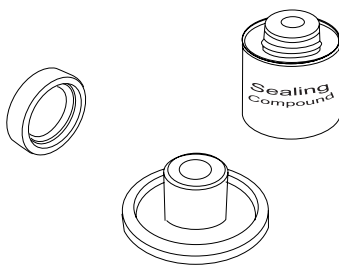
Clean parts in solvent and dry thoroughly.

Some screw holes have special *Heli-Coil* inserts that provide a thread-locking feature. Do not clean *Heli-Coil* holes with a thread tap. This will damage the *Heli-Coil* inserts and force their replacement.

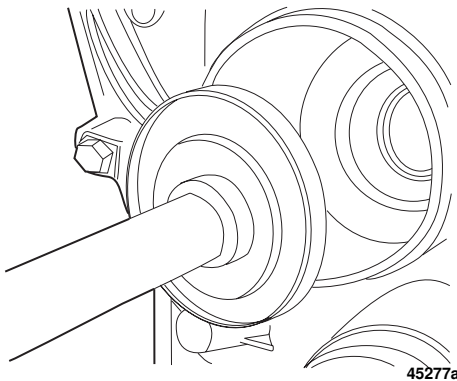
Locking *Heli-Coils* are available only from *Volvo Penta Parts*. See your parts catalog.

Gimbal Housing Assembly

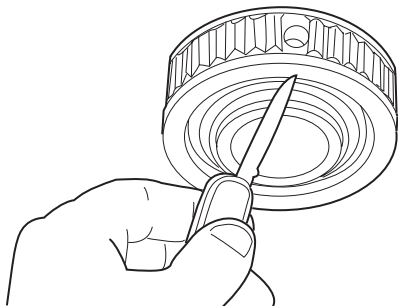
Steering Bearing, Gimbal Bearing and Seal Installation



48639

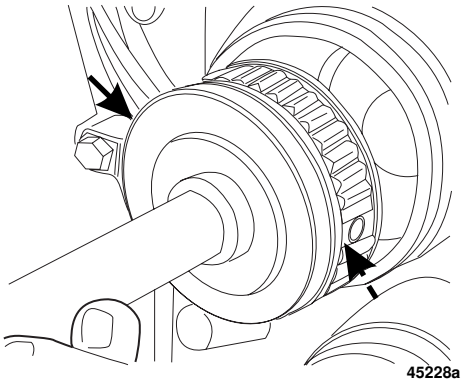


45277a

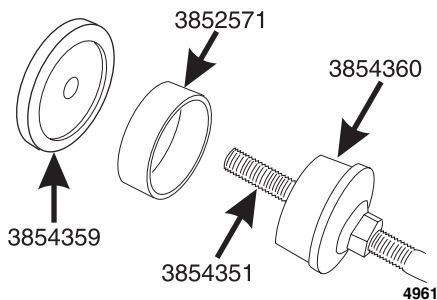


4959

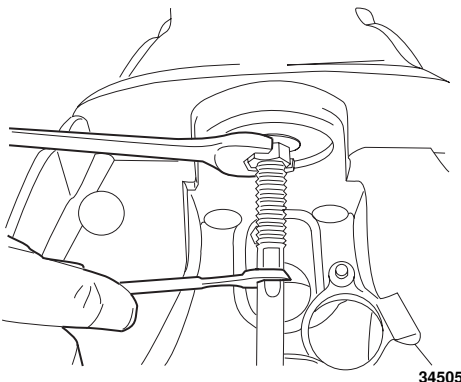
1. Face the open end of a new gimbal housing seal toward Installer, *Volvo Penta* P/N 3850038, and place it on the projecting nose of the tool. Lightly coat the metal case with *Volvo Penta Gasket Sealing Compound*.
2. Screw the installer onto Drive Handle, *Volvo Penta* P/N 3850609. Drive the seal into the housing until it seats. Coat the seal lip with *Volvo Penta Grease* P/N 828250.
3. To ensure adequate lubrication of the gimbal bearing, it must be correctly positioned prior to installation. Rotate the outer band until its slot aligns with the lubrication hole. Scribe a reference mark at this point on the bearing case.



4. Screw the seal installation side of Installer P/N 3850038 onto Drive Handle P/N 3850609. Oil the exterior of the bearing case. Place the bearing with the reference mark facing the extension tube opening, onto the installer. Drive the bearing into the housing until it seats. Lubricate the bearing with Wheel Bearing Grease through the grease fitting on the starboard side of the housing.



5. To install the upper steering bearing, slide Installer *Volvo Penta* P/N 3854360 onto Rod, *Volvo Penta* P/N 3854351 then place a new bearing *Volvo Penta* P/N 3852571 on the installer. Lightly oil the outside of the bearing.
6. The installer, *Volvo Penta* P/N 3854359, will act as a stop to seat the bearing. When positioned inside the steering arm cavity, the recessed side of the tool must face the bearing as shown.

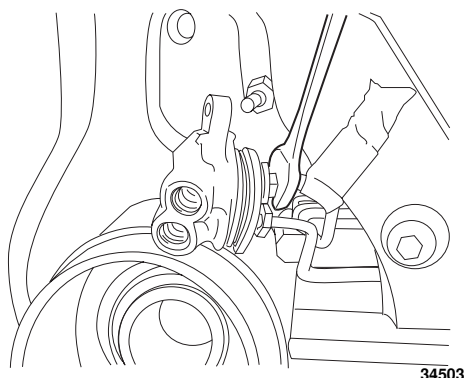


7. Face recessed side of Installer, *Volvo Penta* P/N 3854359 down and insert it into the steering arm cavity from inside the boat. Screw puller rod into the installer until it's flush with the top of the installer. Hold the rod and tighten the nut until the bearing seats.

Hydraulic Lines and Manifold Installation

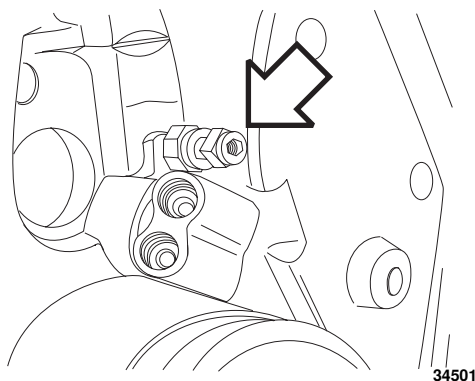


1. Coat a new O-ring with *Volvo Penta* Gasket Sealing Compound P/N 1161099 and place it on the manifold.
2. Lubricate two new O-rings with hydraulic fluid and place them on the hydraulic line tips.

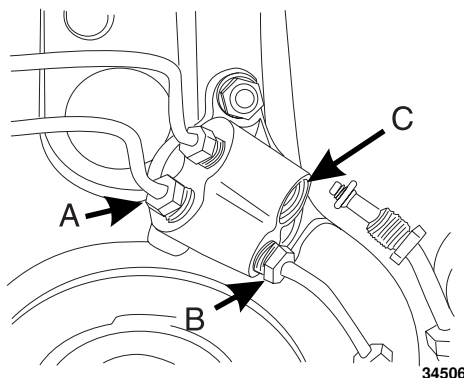


3. Hold the manifold as shown and attach the lines. Make sure the tagged line goes in its proper location. Route both lines parallel and at the angle shown. Line routing is important otherwise manifold will be difficult or impossible to install. Tighten the fittings to 84-108 in. lb. (9,5-12,2 N.m) and discard the reference tag.

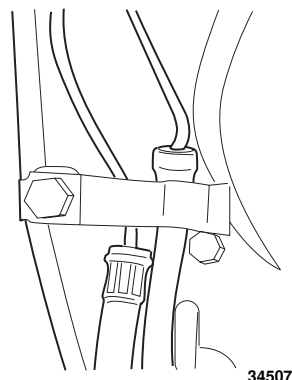
Tagged line must attach to the correct inlet. **If lines are switched, trim/tilt mechanism will malfunction.** When properly connected, the lower manifold line will attach to the “UP” inlet on the pump valve body, and the upper manifold line will connect to the starboard inlet on the pump body.



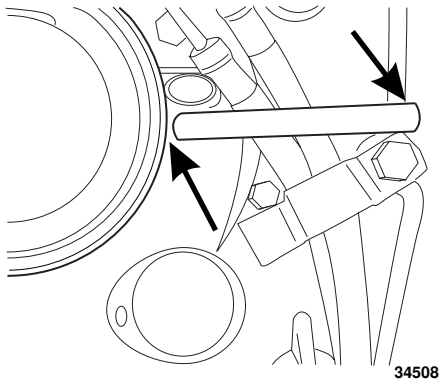
4. Feed the lines through the manifold opening, pulling them from inside the transom if necessary. Seat the manifold over its mounting stud. Use a new locknut and tighten nut to 108-132 in. lb. (12-15 N.m).



5. Coat new O-rings with hydraulic fluid and place them on hydraulic lines. Attach the lower port line (A) to the manifold first, then the upper one. Tighten the fittings to 84-108 in. lb. (9,5-12,2 N.m). Attach the short starboard line (B) to the lower port of the manifold. Attach the long starboard line (C) to the upper port of the manifold. Tighten the fittings to 84-108 in. lb. (9,5-12,2 N.m).

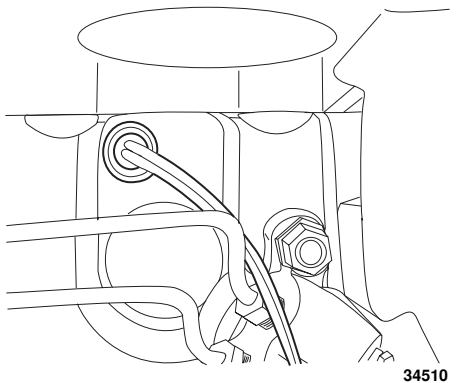
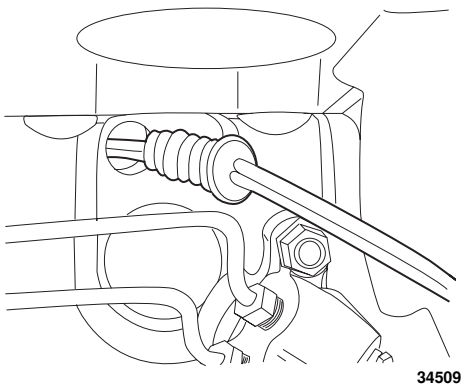


6. Route the lines together down the side of the housing. Install the clamp and screw, tighten the screw securely.



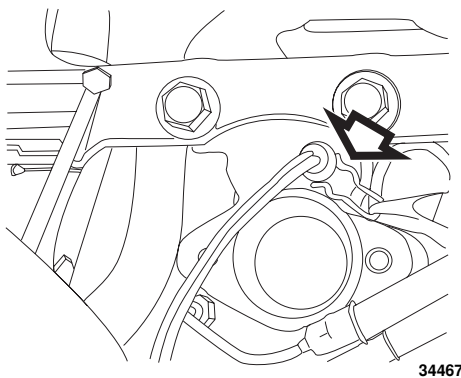
7. If the grease extension tube was removed, install it as follows:
 - a. Remove the grease fitting from the tube. Apply *Volvo Penta Gasket Sealing Compound* P/N 1161099 to the last 1/4 in. of the grease fitting end of the tube. Insert the tube through the outer wall of the housing.
 - b. Spray the tapered end of the tube and housing hole with *Loctite Primer* and allow to air dry.
 - c. Sparingly apply *Volvo Penta Thread Locking Fluid* P/N 1161053 to the tapered end of the tube and drive the tube into the housing until it seats. Wipe away any excess adhesive that may enter the bearing cavity or the end of the tube. Install the grease fitting.

Trim Sender Installation

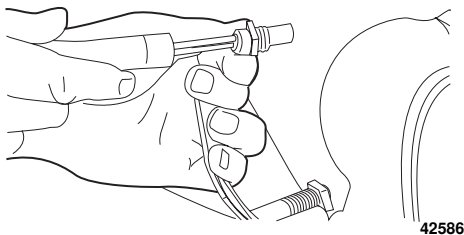


1. Apply *Volvo Penta Grease* P/N 828250 to the trim/tilt sender lead grommet. Feed the wires through the opening in the rear of the gimbal housing, and out through the transom plate. Push the grommet into the hole until it seats.

Note! Do not route trim/tilt sender leads under extension tube or hydraulic lines. Leads must be free to move when drive unit steers, otherwise sender or wire will be damaged.



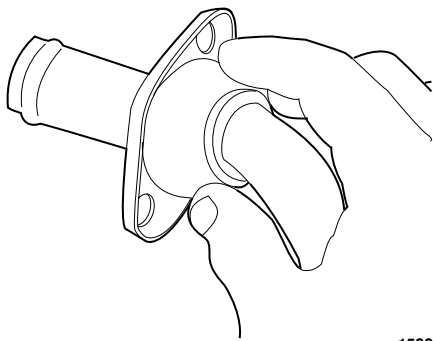
2. Attach the retaining clip to the grommet inside the transom plate.



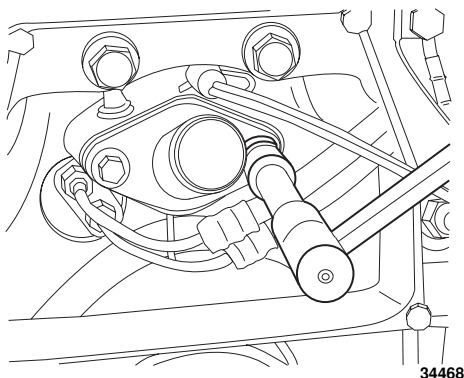
3. Install the RIBBED BLACK wire in the "A" terminal, the WHITE wire in the "B" terminal and SMOOTH BLACK wire in the "C" terminal on the *Amphenol* connector. Use Socket Installer, *Volvo Penta* P/N 3854349, to push the wire sockets into the rubber plug until they seat.

Note! The use of alcohol will make socket installation into the rubber plug easier.

Water Tube Installation

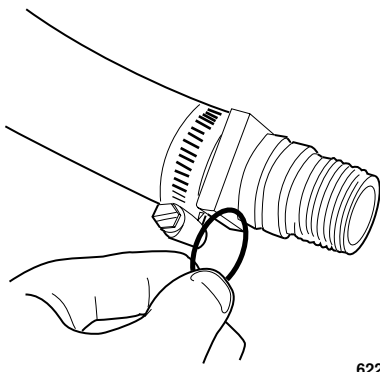


1. If the grommet was discarded, face the tapered end of a new one toward the hooked end of the tube and slide it up against the flange.



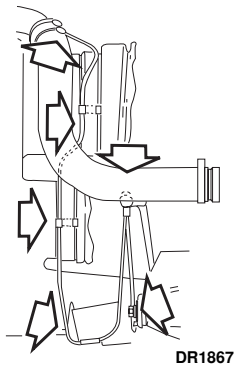
2. From inside the boat, insert the hooked end of the tube through the gimbal housing. Hold the tube vertically, then install the two mounting screws and tighten them to 120-144 in. lb. (14-16 N.m).

Water Hose Installation



1. Remove and discard the nipple O-ring. Clean all grease from the nipple making sure the drain hole is clear. If the nipple needs to be replaced, remove the clamp and pull it out of the hose. Install a new nipple and secure with a clamp. Tighten the clamp securely.
2. Coat a new O-ring with *Volvo Penta Grease P/N 828250*. Slide it onto the nipple and position it in the groove closest to the square at the end of the fitting. Clean excess grease out of drain hole and drain groove.

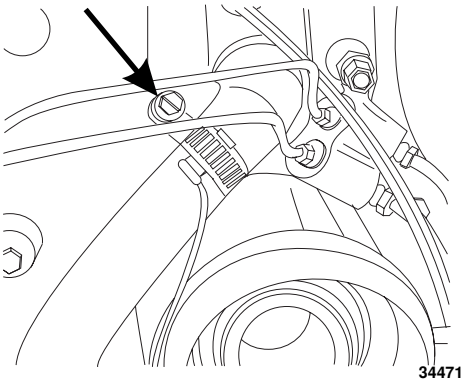
Note! Do not place an O-ring in the drain hole groove. This would prevent water draining out during winterization, and could result in freeze damage.



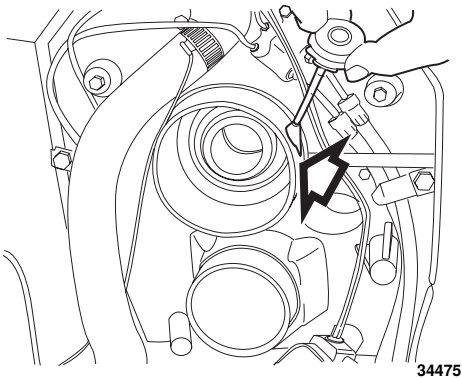
3. Slide a clamp onto the upper end of the hose. Position the screw head so that it will be behind the port hydraulic lines as shown. Push the hose onto the water tube, then rotate it until the nipple points directly outward. Slide the ground strap clip under the hose clamp. Tighten the clamp securely.

Note! Clamp's screw head must be behind hydraulic lines to prevent it contacting the pivot housing when drive is in a full tilt position. Improper clamp position may limit tilt range, and damage clamp and hose.

4. Check the position of the nipple drain hole. If it's not facing down, loosen the nipple clamp and rotate nipple until the drain hole is facing down. Tighten clamp securely.

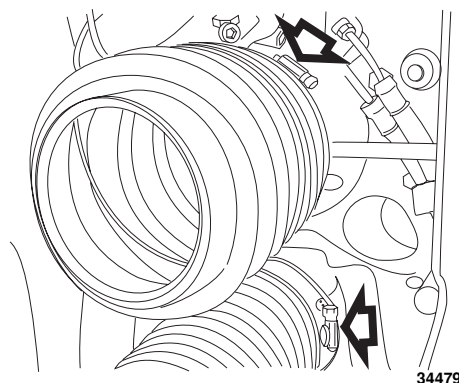


U-joint and Exhaust Bellows Installation

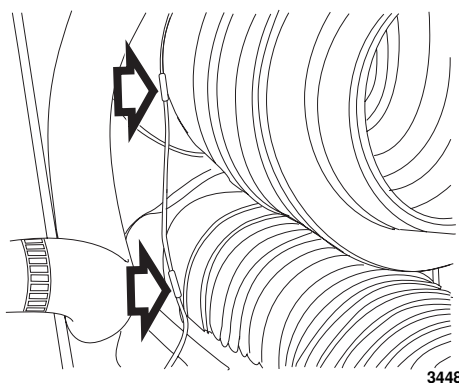


1. Coat the outside surface of the gimbal bearing bore with *Volvo Penta Gasket Sealing Compound*. Sealer is not required on the outside of the exhaust opening.

Note! Clamp's screw position is important. If not properly positioned, steering radius will be reduced because of gimbal ring contacting clamp head when turning.



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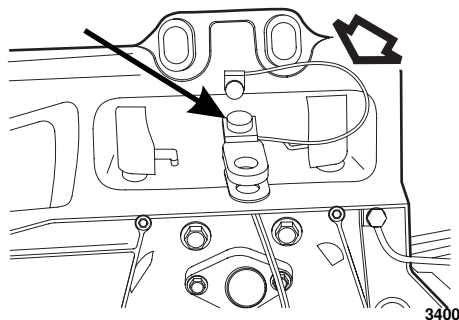
2. Place clamp on the small end of the U-joint bellows. There is an internal rib that must engage a corresponding groove around the opening's surface. Push the bellows on and engage the groove, then rotate the clamp until the screw fitting is in the one or two o'clock position. Slide ground strap clip under hose clamp. Tighten the clamp securely.
3. The large end of the exhaust bellows has an internal rib similar to the U-joint bellows. Place clamp on this end. Bellows must be positioned with exhaust relief cutout facing down. Push the bellows onto the exhaust tube until it engages the groove. Turn the clamp screw to the three o'clock position. Slide ground strap clip under hose clamp and tighten the clamp securely.
4. Install gimbal ring, trim/tilt cylinders and pivot housing following instructions elsewhere in this section.

Gimbal Housing Removal

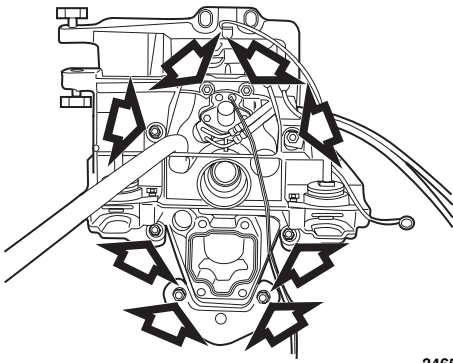
Remove engine, lower exhaust pipe and steering cylinder following instructions in Stern Drive Engine Removal and installation section in the Engine Service Manual.

Note! The transom shield assembly can be removed without complete disassembly. Since the gimbal housing is attached to the trim lines and pump, decide whether to disconnect trim lines at hydraulic manifold after inner transom plate is removed, or to unscrew trim pump from transom and feed pump and lines through cutout as gimbal housing is removed.

1. Remove the screw and washer securing the transom plate ground strap to the steering arm.

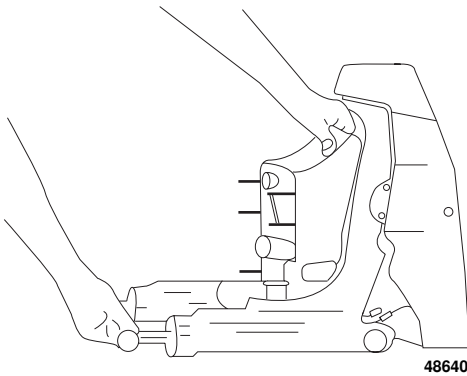


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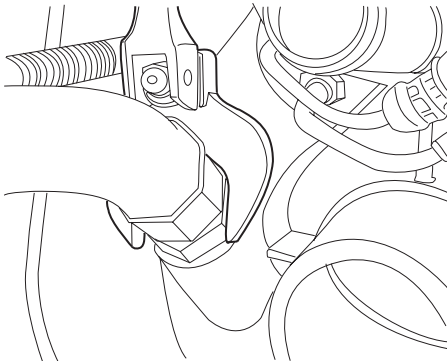
2. Remove the two screws and four nuts and washers securing the transom plate inside the boat. Lift the plate off the studs. Note that the hydraulic lines route above the uppermost port stud and through a relief in the inner transom plate.



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3. Remove the two remaining nuts, washers, and transom bearing plate. Pull the gimbal housing off the transom.

Shift Cable Sleeve Replacement



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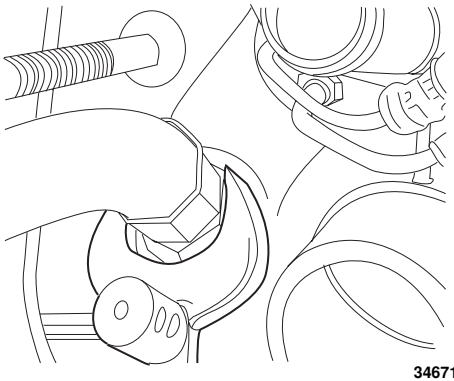
1. Unscrew the shift cable sleeve and connector assembly. Discard the connector O-ring.



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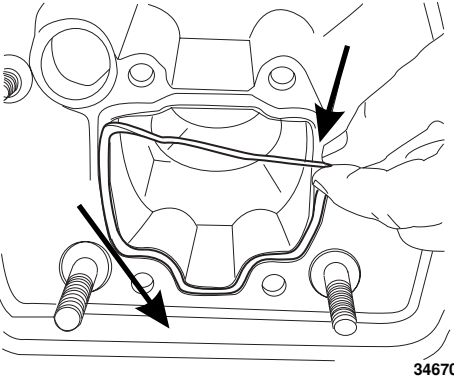
2. Apply *Volvo Penta Gasket Sealing Compound* to a new O-ring. Slide it onto the connector and position it against the hex then coat the connector threads with sealer.

3. Install the sleeve and connector assembly, and use a crowfoot adapter to tighten the connector to 40-45 ft. lb. (54-61 N.m).

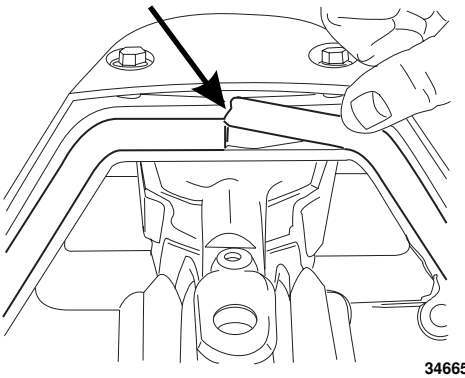


Transom and Exhaust Seal Replacement

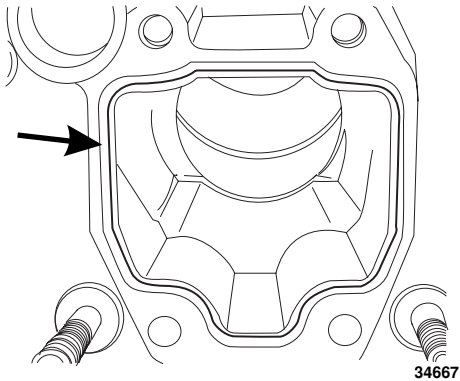
1. Remove and discard the exhaust O-ring seal and the large rubber transom seal.



2. Apply 3M Scotch Grip Rubber Adhesive 1300 to the entire transom seal groove around the gimbal housing. Start at top and firmly push a new seal into the groove. Also apply 3M Scotch Grip Rubber Adhesive 1300 to the seal ends and butt them together to form a watertight junction at the top of the gimbal housing.

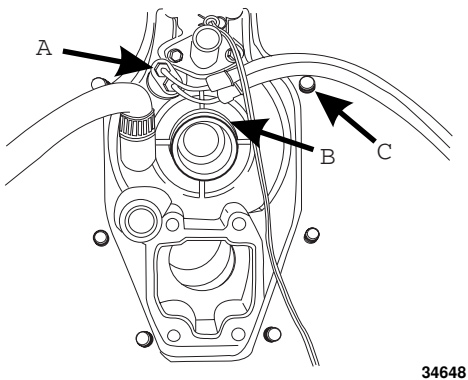


3. Apply 3M Scotch Grip Rubber Adhesive 1300 in the exhaust groove, and install a new O-ring seal.

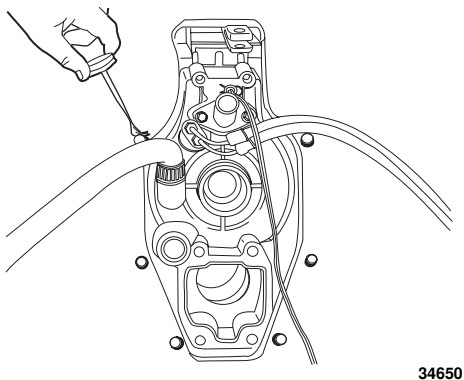


Gimbal Housing Installation

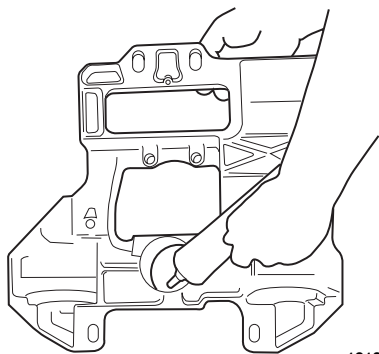
1. 1. Thoroughly clean outer transom surface where gimbal housing seal makes contact. If trim pump and lines are already attached to housing, insert them through transom cutout, then install gimbal housing. Do not use sealer between housing seal and transom, and do not attach washers or nuts at this time.
2. If trim lines were previously disconnected, attach them to the hydraulic manifold (A). **Note: Line from pump “UP” outlet must attach to lower manifold opening, otherwise trim system will not function properly.** Route the lines above the alignment tube (B) and over the uppermost port stud (C) as shown.



3. Lightly coat the six gimbal housing studs with *Volvo Penta Gasket Sealing Compound*.

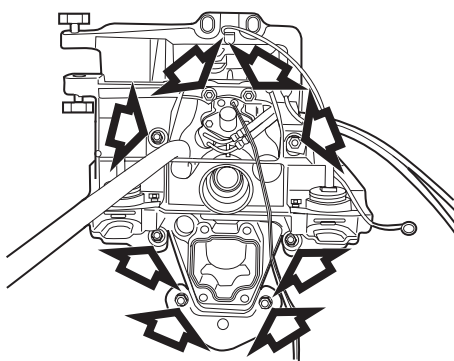


4. Apply a light coat of *Volvo Penta Grease P/N 828250* to the inside of the transom plate alignment tube.



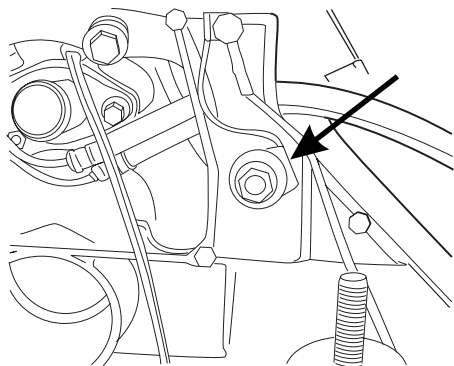
18121

5. Position the two hydraulic lines above the uppermost port stud and mount the transom plate. Place the transom bearing plate over the two bottom studs, flat side against transom. Install three flat washers and five new locknuts. Tighten nuts until they just contact plate and transom. **Do not tighten nuts at this time.**



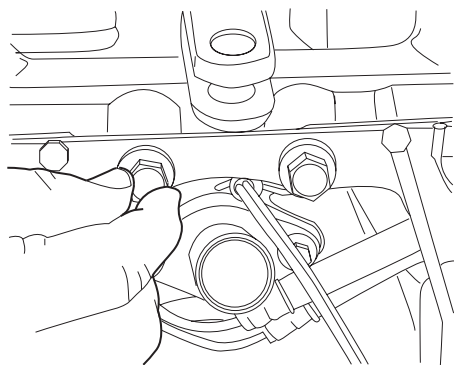
34654

6. Position ground wire on transom shield stud. Install washer and locknut. **Do not tighten nut at this time.**



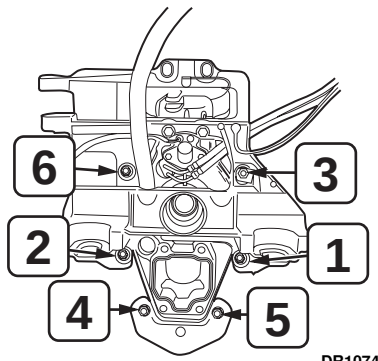
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7. Lightly coat the alignment screw threads with *Volvo Penta Grease P/N 828250*, then screw them completely in only finger tight. Do not tighten the alignment screws at this time.



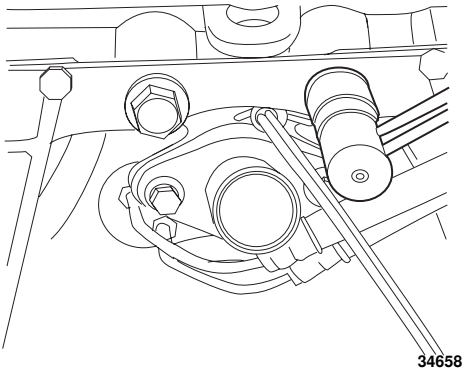
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8. Tighten the six locknuts in a cross pattern, starting with the two center nuts. Tighten them to of 20-25 ft. lb. (27-34 N.m).



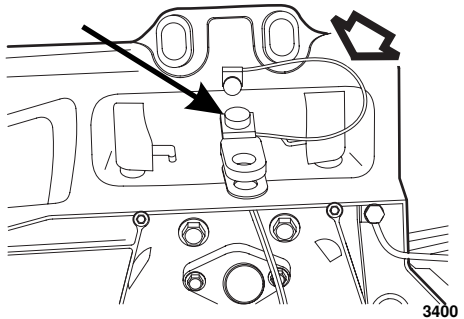
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9. Tighten the two alignment screws to 12-14 ft. lb. (16-19 N.m).



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10. Attach transom plate ground strap to the steering arm and secure with screw and washer. Tighten screw securely.



3400

Torque Specifications

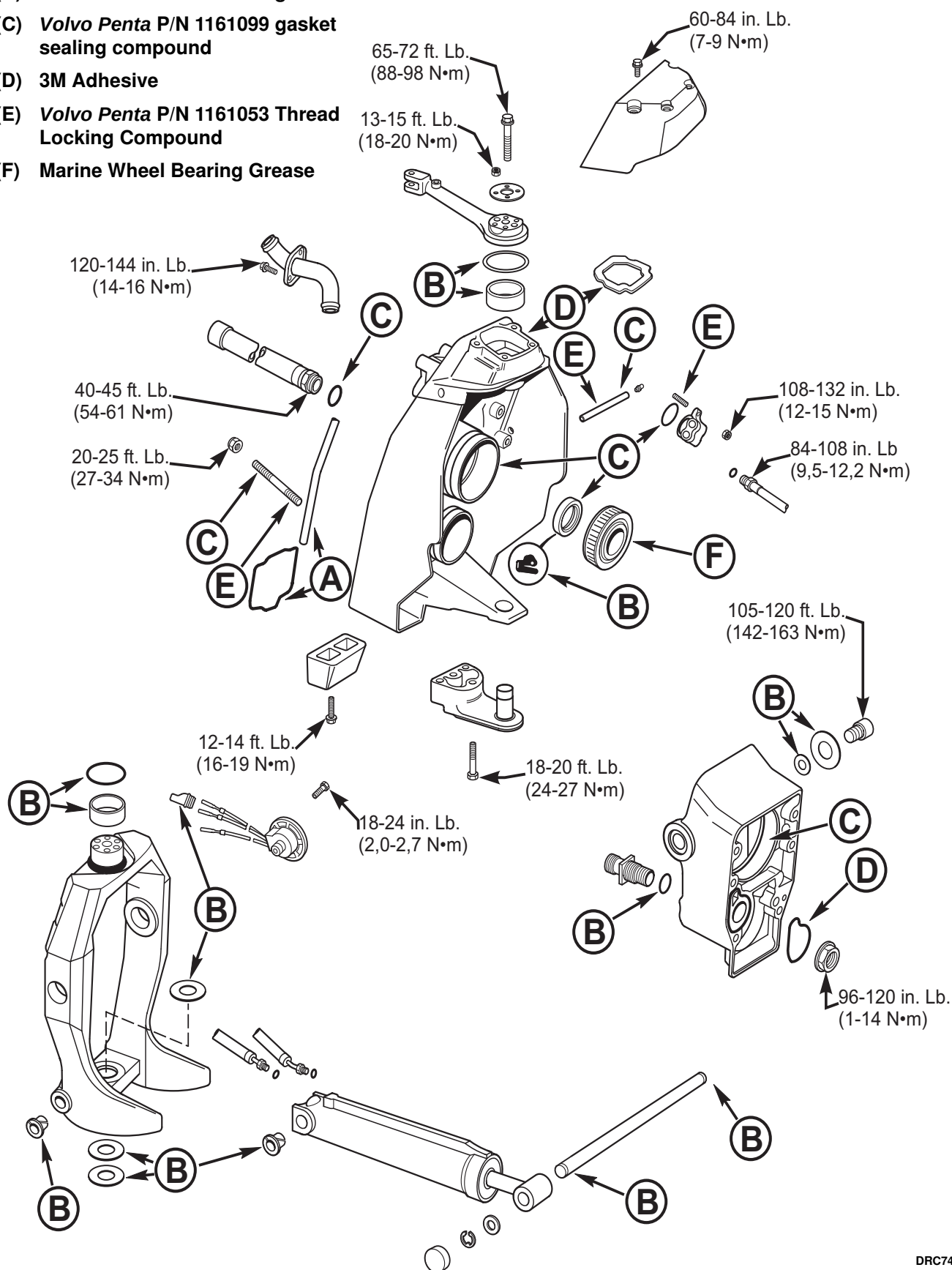
Description	U.S.	Metric
Nut		
Manifold to Transom Shield	108-132 in. lb.	12-15 N•m
Shift Cable Sleeve	40-45 ft. lb.	54-61 N•m
Steering Arm Studs	13-15 ft. lb.	18-20 N•m
Transom Shield Mounting	20-25 ft. lb.	27-34 N•m
Trim Line to Cylinder/Manifold	84-108 in. lb.	9,5-12,2 N•m
Trim/Tilt Pivot Pin	120-144 in. lb.	14-16 N•m
Water Nipple	96-120 in. lb.	11-14 N•m
Screw		
Alignment, Inner Transom Plate	12-14 ft. lb.	16-19 N•m
Anode	12-14 ft. lb.	16-19 N•m
Cover, Gimbal Housing	60-84 in. lb.	7-9 N•m
Pivot Housing to Gimbal Ring	105-120 ft. lb.	142-163 N•m
Support Bracket, Gimbal Ring	18-20 ft. lb.	24-27 N•m
Trim Sender	18-24 in. lb.	2,0-2,7 N•m
Water Outlet	120-144 in. lb.	14-16 N•m
Bolt		
Steering Arm	65-72 ft. lb.	88-98 N•m

Sealants, Lubricants, and Adhesives

Adhesives	Where used
<i>Volvo Penta Thread Locking Fluid</i> P/N 1161053	Stud, Gimbal Housing Lubrication Tube Stud, Manifold
3M Adhesive	Seal, Water Passage Seal Ring, Gimbal Housing Cover
3M Scotch Grip Rubber Adhesive 1300	Seal, Exhaust Opening Transom Seal
Lubricants	Where Used
<i>Volvo Penta Grease</i> P/N 828250	Alignment Tube, Inner Transom Plate Bushing, Upper Steering Post Friction Washer, Pivot Housing Grommet, Trim Sender Lead Nylon Bushing, Trim Cylinder O-ring, Upper Steering Post O-ring, Water Nipple Pivot Pin, Trim/Tilt Cylinder Seal Lip, Gimbal Housing Thrust Washer, Lower Steering Post Thrust Washer, Pivot Bolt Thrust Washer, Upper Steering Bearing Gimbal Bearing, Driveshaft
Sealants	Where Used
<i>Volvo Penta Gasket Sealing Compound</i> P/N 1161099	Alignment Screw, Transom Plate Gimbal Housing Lip, U-joint Bellows Lubrication Tube O-ring, Hydraulic Manifold O-ring, Shift Cable Tube Pivot Housing Lip, U-joint Bellows Pivot Pin Threads, Trim/Tilt Seal Case, Gimbal Housing Studs, Gimbal Housing

Service Chart

- (A) 3M Scotch Grip rubber adhesive 1300
- (B) Volvo Penta P/N 1141644 grease
- (C) Volvo Penta P/N 1161099 gasket sealing compound
- (D) 3M Adhesive
- (E) Volvo Penta P/N 1161053 Thread Locking Compound
- (F) Marine Wheel Bearing Grease



DRC7454

Transom Shield Assembly SX-MHP

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Safety Warnings Before working on any part of the transom bracket assembly, read the section called Safety at the end of this manual.

When replacement parts are required, use genuine *Volvo Penta* or parts with equivalent characteristics including type, strength and material. Failure to do so may result in product malfunction and possible injury to the operator and/or passengers.

Some screw holes have special *Heli-Coil* inserts that provide a thread-locking feature. Do not clean *Heli-Coil* holes with a thread tap. This will damage the *Heli-Coil* inserts and force their replacement.

Special Tools

Tool Name	Volvo P/N	Panel Location
Drive Handle	3850609	A
Driver	3854356	E
Insert Tool	3854349	B
Installer	3854359	E
Installer	3854360	E
Installer	-	K*
Remover/Installer	3854355	E
Remover/Installer	3845358	E
Retaining Ring Pliers	3850608	B
Rod	3854351	C
Socket Removal Tool	3854350	B

* Same panel position as obsoleted Installer, P/N 912279.

Owatonna Service Tools OEM 4184Slide Hammer

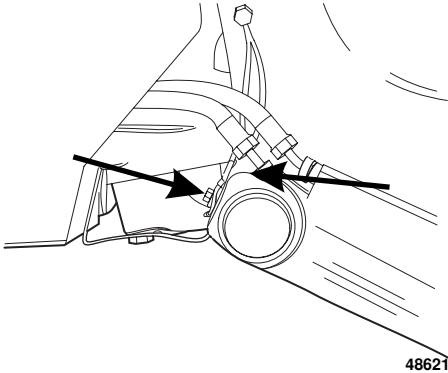
Order From: OTC Division of SPX Corporation
 655 Eisenhower Drive
 Owatonna, Minnesota 55060 USA
 Toll free order line:1-800-533-5338 or 1-800-533-0492
<http://www.otctools.com>

Sealants, Lubricants and Adhesives

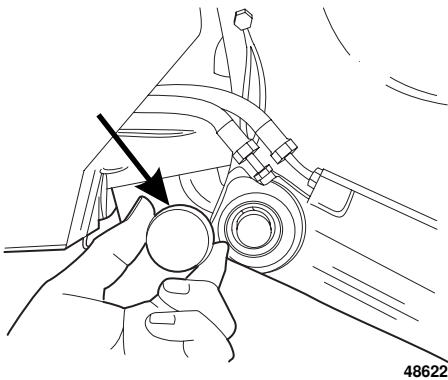
Cleaning Solvent
Volvo Penta Gasket Sealing Compound P/N 1161099
Loctite Primer N
Volvo Penta Thread Locking Compound P/N 1161053
Volvo Penta Grease P/N 828250
 3M Adhesive
 Wheel Bearing Grease
 Remove the sterndrive following the procedure in **Sterndrive Removal and Installation** section in this manual. If the complete transom bracket assembly is being rebuilt or replaced, remove engine following procedure in the **Installation Manual**.

Trim/Tilt Cylinder Removal

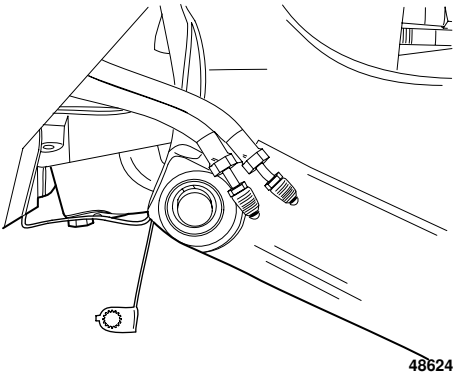
1. Remove screw and ground wire from the front of the cylinder.



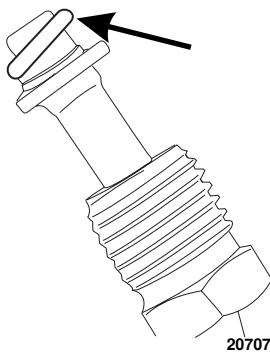
2. Carefully remove pivot pin cap.

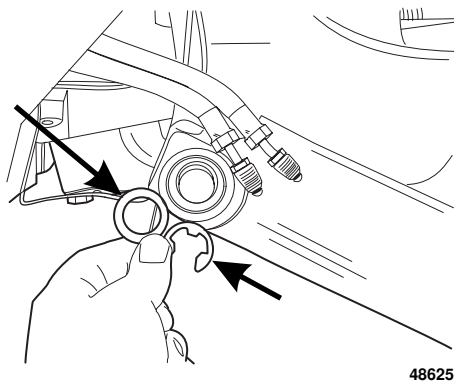


3. **Wear safety glasses:** Cover fittings with a shop cloth, and disconnect trim/tilt lines.



4. Remove and discard trim/tilt line O-rings.

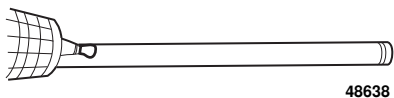




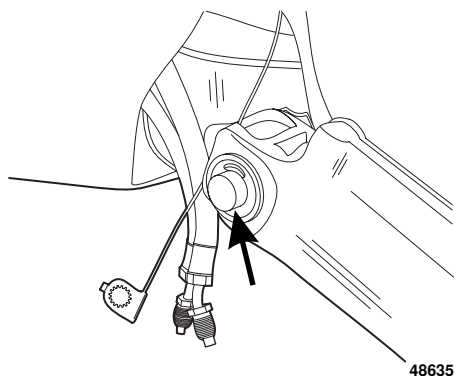
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5. **Wear safety glasses:** Remove pivot pin E-clip and flat washer. Pull pivot pin out of cylinder, gimbal ring, and cylinder on opposite side. Remove bushing from gimbal ring and replace if necessary. Remove cylinder and set aside to drain.
6. Remove the ground wire and hydraulic lines from the remaining cylinder.

Trim/Tilt Cylinder Installation

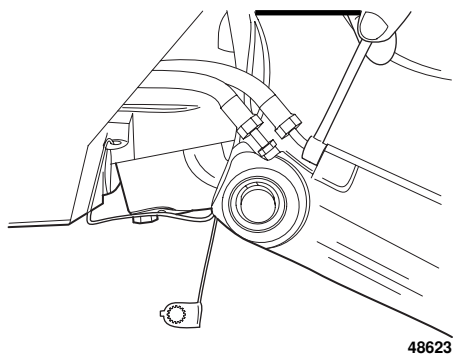


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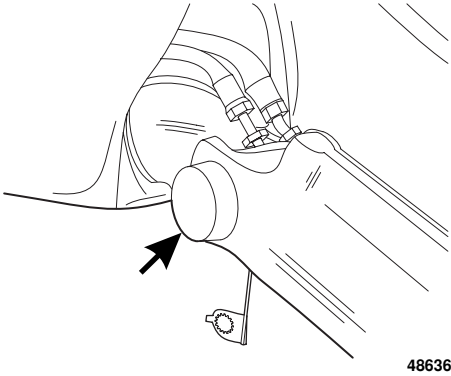
1. Remove the remaining E-clip and washer from the pivot pin. Clean the pivot pin, then coat it with *Volvo Penta Grease P/N 828250*.
2. Replace the gimbal ring's bushings if they're damaged, then slide the pivot pin through the cylinders and gimbal ring.
3. Center the pivot pin. Install both washers and E-clips.



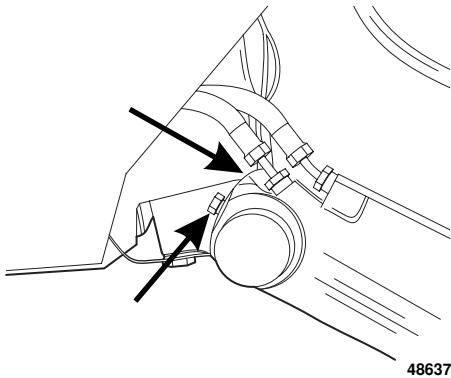
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4. Place a new O-ring on the trim/tilt cylinder line fittings and attach lines to cylinder. Tighten line fittings to 84-108 in. lb. (9,5-12,2 N.m).

5. Install pivot pin caps.



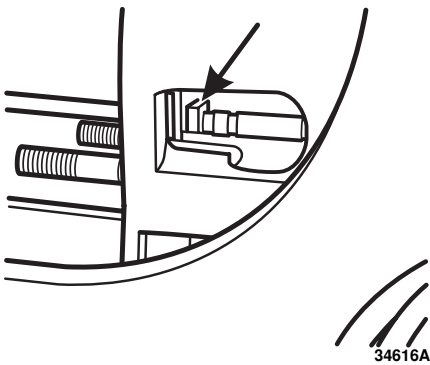
6. Attach ground wires to front of trim/tilt cylinders. Tighten screws securely. To fill and bleed the trim cylinders and trim motor reservoir, see **Filling and Bleeding Dry System** in **Trim/Tilt Hydraulic System** section of this manual.



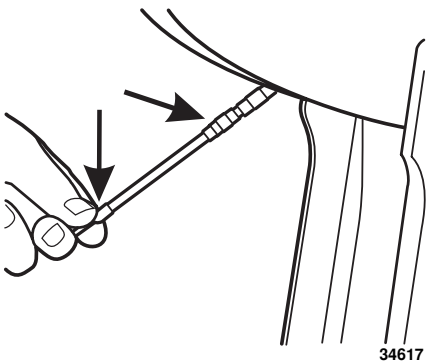
Pivot Housing Removal

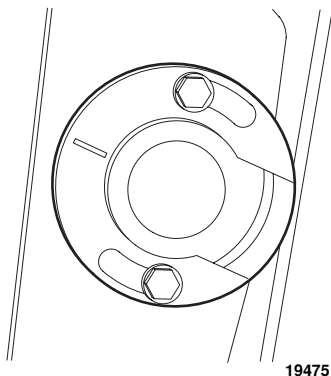
Remove the sterndrive following the procedure in **Sterndrive Removal and Installation** section in this manual.

1. Turn sterndrive to port. Loosen anchor clamp screw and slide clamp to starboard disengaging the remote control shift cable.

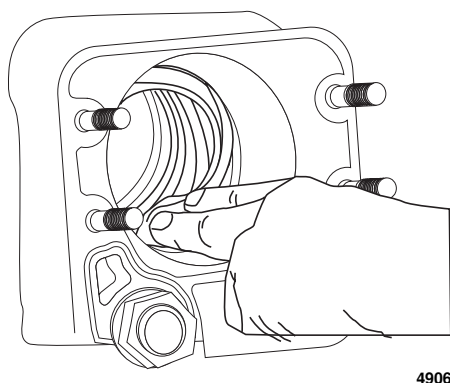


2. Remove shift cable from the pivot and gimbal housing. Remove the small and large seals. From inside of boat, pull shift cable out of the sleeve and connector assembly.

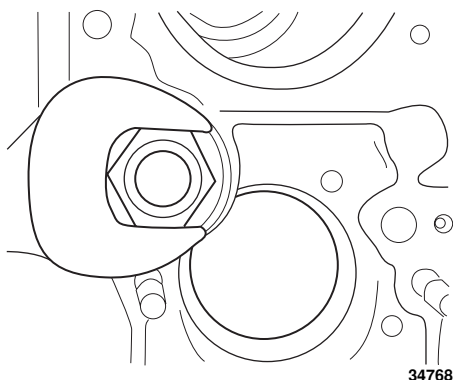




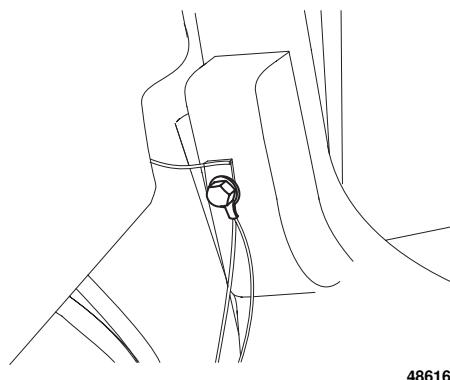
3. Turn the gimbal to port and remove the two screws holding the trim sender. Do not attempt to pull out the sender as its leads are secured to the transom bracket.



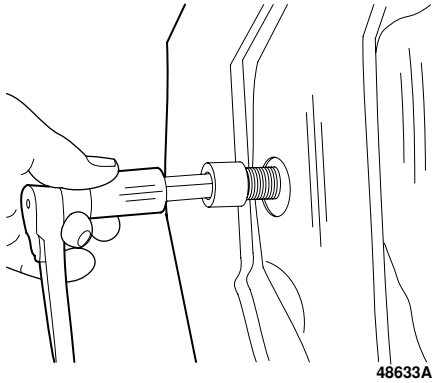
4. Disengage the U-joint boot from the lip of the pivot housing and push it inside.



5. Unscrew the nut securing the water hose nipple, and push the nipple through the housing as far as possible.

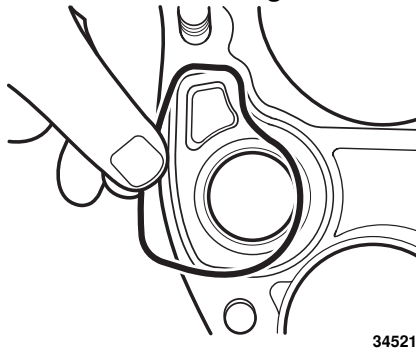


6. Turn gimbal ring to the starboard. Remove screw and both ground straps.

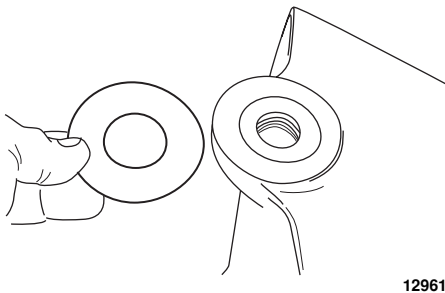


7. Use a 1/2 in. hex drive wrench or socket and remove both pivot pins.

Pivot Housing Disassembly



1. Remove and discard the cooling passage O-ring.



2. Inspect the nylon friction washer on the pivot bosses. Peel them off and discard them if they're damaged. Remove and inspect the thrust washer underneath.

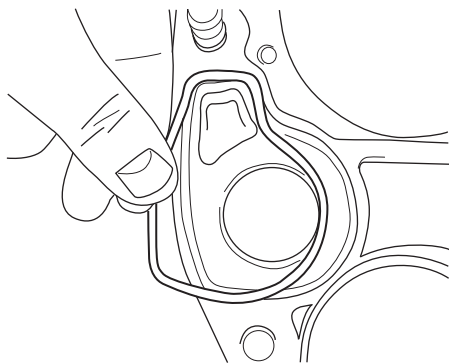
Cleaning and Inspection

Clean housing in solvent and dry thoroughly. Remove sealer and/or adhesive from the cooling passage opening, U-joint bellows opening, and pivot bosses.

Note! Clean screw holes with solvent only. A thread tap would damage the *Heli-Coil* inserts and force their replacement.

- **O-ring Seal Groove** - Check for sharp edges that would prevent O-ring sealing water passage.
- **Mounting Studs** - Look for damaged threads and looseness.
- **Ground Wire** - Check wire ends for frayed or loose connections. Repair or replace all suspect components.

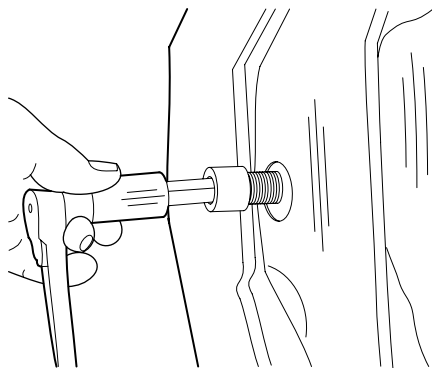
Pivot Housing Assembly



34523

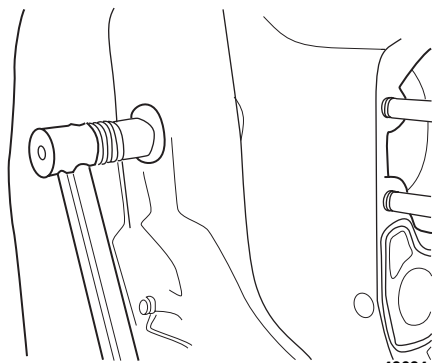
1. Apply 3M Adhesive to the groove around the water passage, and install a new O-ring seal.
2. If the old pivot boss friction washers were removed, make sure a thrust washer coated with *Volvo Penta Grease P/N 828250* is installed in each pivot. Install two new friction washers and coat them with *Volvo Penta Grease P/N 828250*.

Pivot Housing Installation



48633A

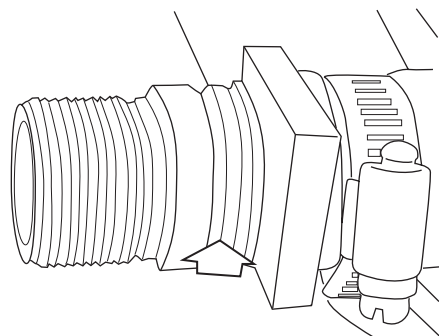
1. Position the pivot housing in the gimbal ring. Guide the water tube nipple through the housing, and position the bellows behind their respective openings.
2. Align one gimbal ring pivot pin hole with the hole in the pivot housing. Look inside to see if the thrust washer is still in position and not blocking the hole. Screw in the pivot pin until it seats, **but do not tighten** it at this time.



48634

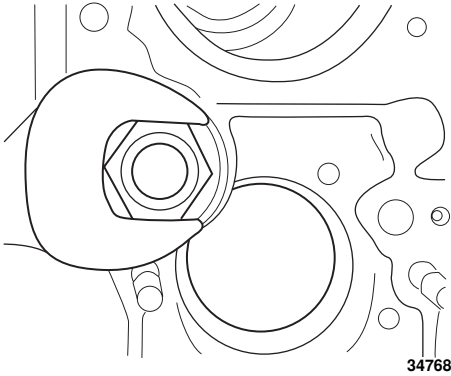
3. Align and install the other pivot pin. Tilt the housing up and down to see if it moves freely. Use a 1/2 in. hex socket and tighten the pivot screws to 105-120 ft.lb.(142-163 N.m).

Note! Hold pivot housing to keep housing from over rotating and damaging bellows and water hose while tightening pivot screws.

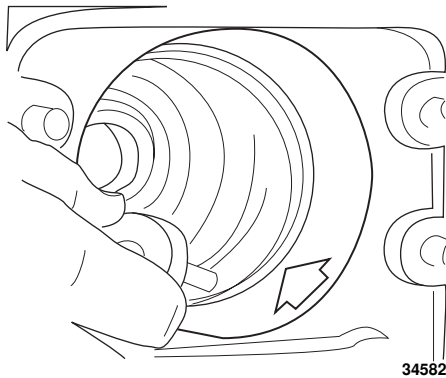


34579

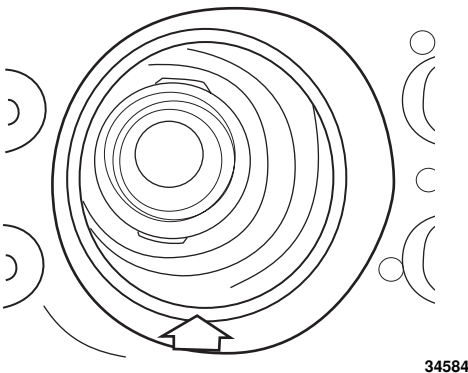
4. The drain hole in the nipple must face down when installed in the pivot housing.



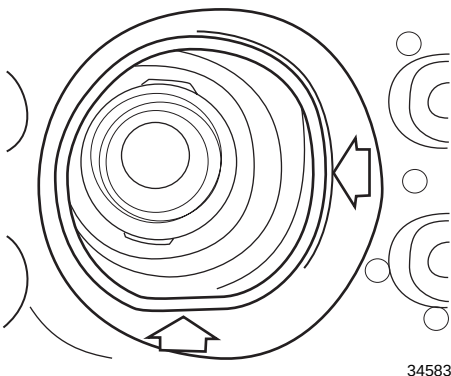
5. Pull the water tube through the pivot housing as far as it will go. Screw on the water nipple nut. If the nipple turns with the nut, or if the nipple end does not protrude through the nut when it's seated, then the square nipple collar is not located properly behind the housing. Loosen the nut and rotate the nipple to reposition it. Make sure the drain hole in the nipple faces down. Tighten the nut to 96-120 in. lb. (11-14 N.m).



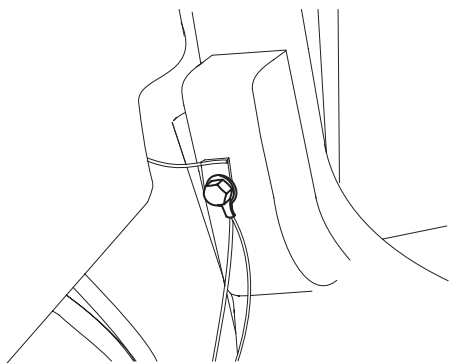
6. Apply *Volvo Penta Gasket Sealing Compound* around the complete inner V-shaped lip of the pivot housing, to seal the U-joint bellows against water entry.



7. Pull the U-joint bellows through the opening and seat the lip in the groove.



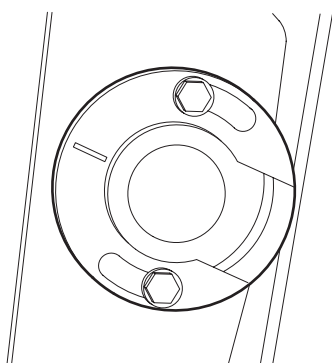
8. Bellows must seal the entire circular opening; any flat spot on the lip indicates the bellows has not engaged the V-groove.



48616

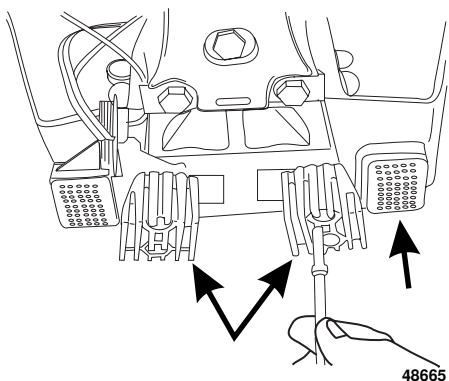
9. Attach the ground wires with screw to the threaded hole on the port side of gimbal ring.
10. Install and adjust the trim sending unit following instructions found under **Trim Sender Adjustment** in this section.

Gimbal Ring Removal



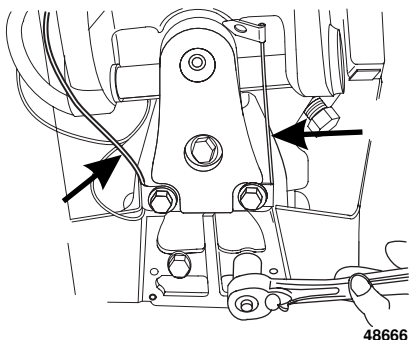
19475

1. Remove trim/tilt cylinders and pivot housing following instructions elsewhere in this section.
2. Turn the gimbal to port and remove the two screws holding the trim sender. Do not attempt to pull out the sender as its leads are secured to the transom bracket.



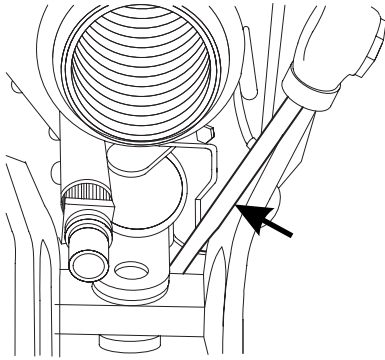
48665

3. Remove four Allen head screws and two anodes from the steering support bracket. Move the anode and sensor housing out of the way.



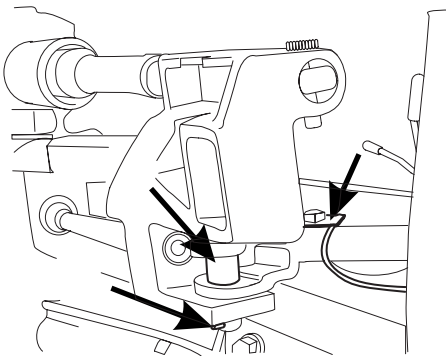
48666

4. Note the position of the two ground straps. Remove the five screws and washers holding the steering support bracket and pull the bracket off.



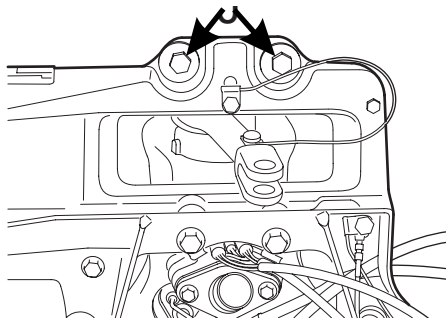
48667

5. If it's tight, use a drift punch and mallet to tap on alternating sides of the bracket until its free.



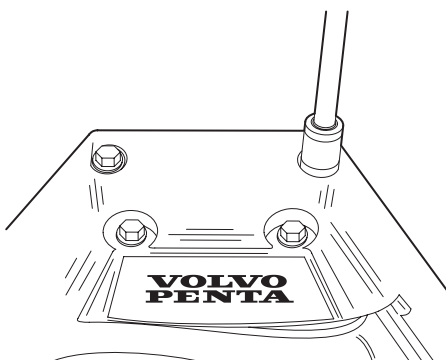
19351

6. Remove cotter pin and steering arm pin. Remove ground strap from steering arm.



48699

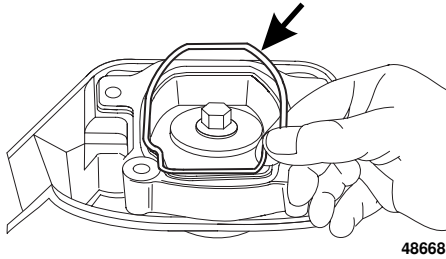
7. Remove two screws securing the gimbal housing cover to the transom.



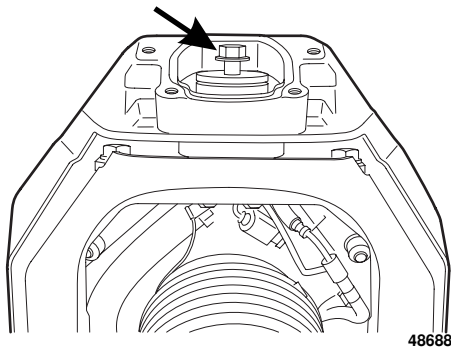
48617

8. Remove four screws and the gimbal housing cover. Remove and discard the two foam seals from the inside of the cover.

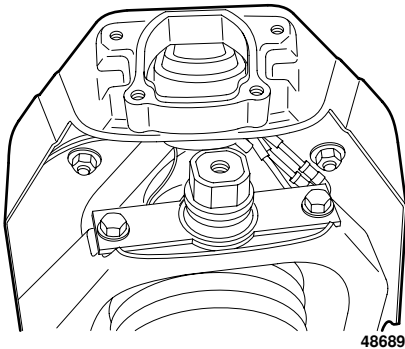
9. Remove and discard the sealing ring.



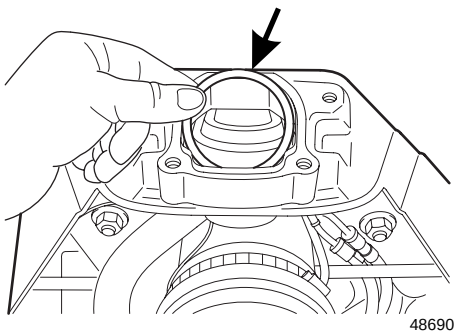
10. Unscrew the steering arm bolt part way out of the gimbal support. Push down on the gimbal ring assembly to remove it from the gimbal housing. If it does not come out easily, lightly tap on the assembly with a rawhide mallet. Finish removing the screw and remove the gimbal ring assembly from the gimbal housing.



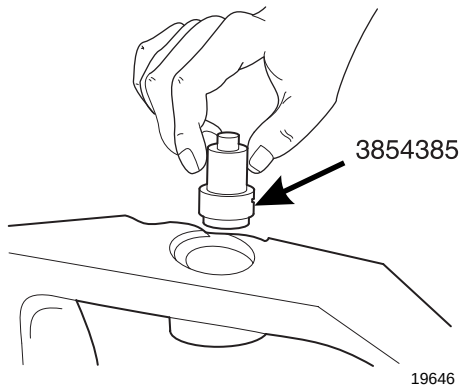
11. Remove the steering arm from inside the boat.



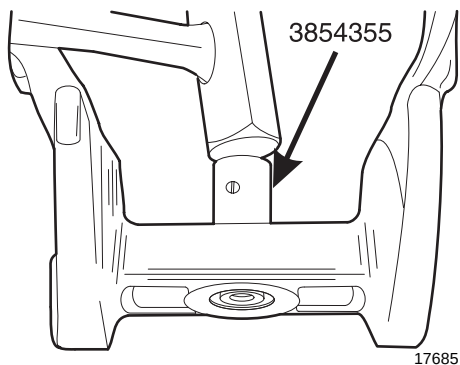
12. Remove thrust washer from the gimbal housing.



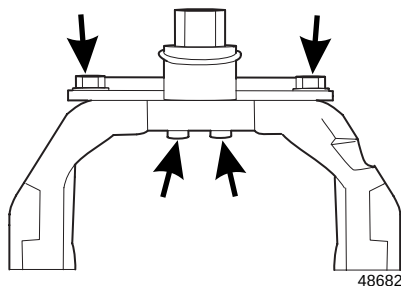
Gimbal Ring Disassembly



1. Remove and discard the O-ring around the upper steering post.
2. Face the large diameter end of Remover/Installer, *Volvo Penta* P/N 3854385 toward the gimbal ring. Insert the tool into either tilt bearing and drive it out. Remove the other tilt bearing in a similar manner.

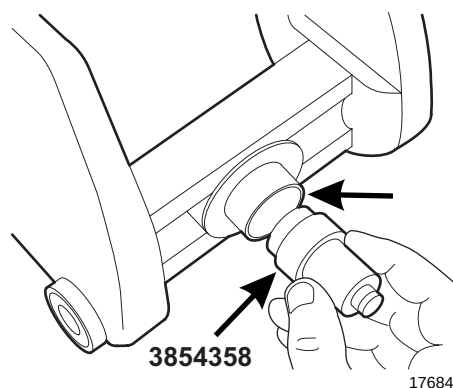


3. Insert small end of Remover/Installer, *Volvo Penta* P/N 3854355 into bearing, and drive out bearing.



4. Remove the support from the gimbal ring only if it needs to be replaced. Remove the two large and two small screws securing the support to the gimbal ring.

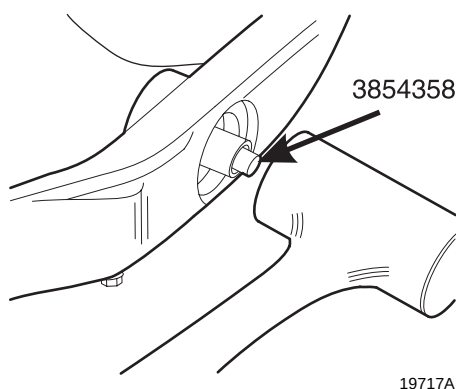
Gimbal Ring Assembly



1. Position the support on top of the gimbal ring. Spray two large screws and two small screws with *Loctite* Primer and allow to air dry. Apply *Volvo Penta Thread locking compound* P/N 1161053 to all screws. Install and tighten screws to 38-59 ft. lb. (51-81 N.m). Install and tighten screws to 13-28 ft. lb. (18-38 N.m).
2. Lightly oil the outside of a new lower pivot bearing and place it in the bore. Use Remover/Installer, *Volvo Penta* P/N 3854358, to seat the bearing into the bottom of the gimbal ring.
3. Install two new trim/tilt nylon pivot pin bushings into the gimbal ring.



4. Apply *Volvo Penta Grease P/N 828250* to the inside of both trim/tilt nylon bushings.



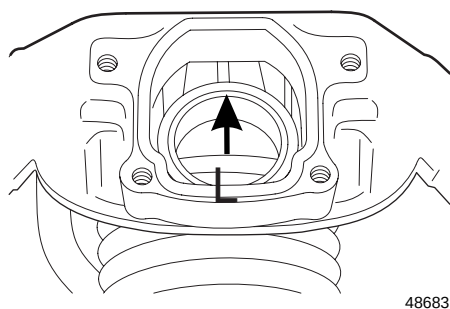
5. Lightly oil the outside of two new tilt bearings. Insert a bearing into the gimbal ring from the outside. Insert the blunt end of Remover/Installer, *Volvo Penta P/N 3854358*, into bearing. Using a soft face hammer, seat bearing flush to 0.010 in. (0,25 mm) below inner surface of gimbal ring. Repeat procedure for installation of the other bearing.

6. If bushing around upper steering post is damaged, it can be removed by splitting it down one side with a sharp tool.

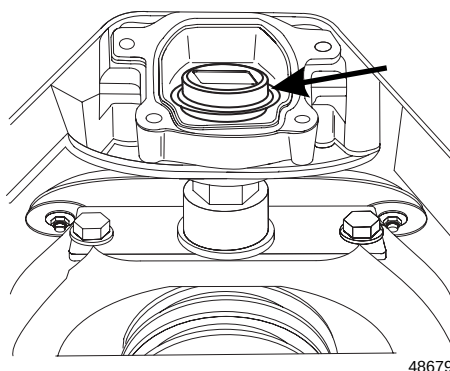
Note! When replacing steering post bushing, check upper bearing inside gimbal housing to see if it also needs replacement.

7. If upper steering post bushing was removed, lubricate inside diameter of a new bushing with *Volvo Penta Grease P/N 828250* and place bushing on top of steering post. Install steering arm and center bolt. Tighten center bolt until bushing seats, then remove center bolt and steering arm.

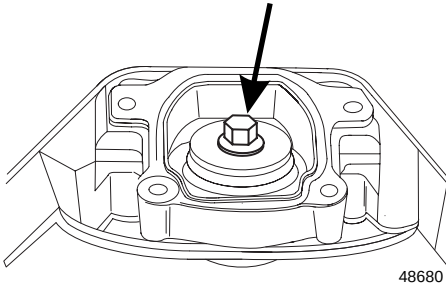
Gimbal Ring Installation



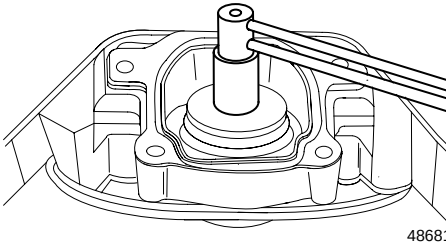
1. Coat a new O-ring with *Volvo Penta Grease P/N 828250* and place it around the base of the upper steering post.
2. Coat the thrust washer with *Volvo Penta Grease P/N 828250* and set it over the upper pivot bearing inside the top of the gimbal housing.



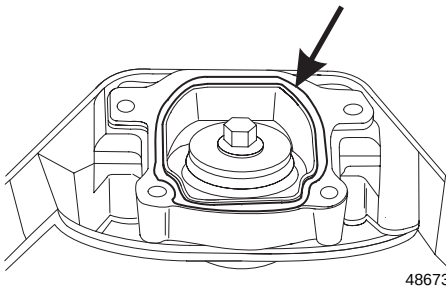
3. From inside of boat, position steering arm over the thrust washer.



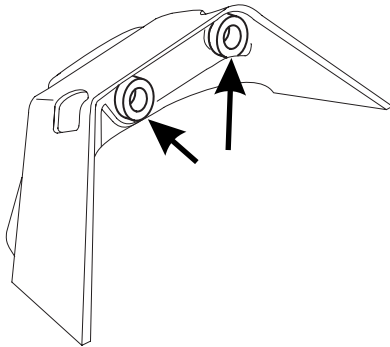
4. Guide gimbal ring steering post up engaging steering arm. Seat the steering post into the steering arm by pushing up. The steering post is a slip fit with the steering arm. Apply *Volvo Penta Gasket Sealing Compound* to the center screw. Install center screw finger tight.



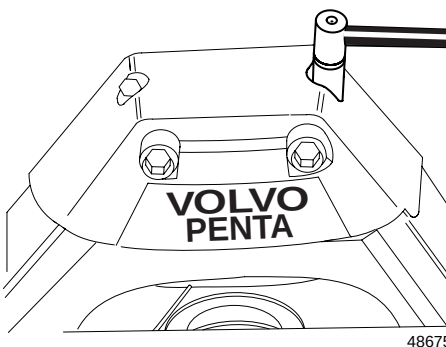
5. Tighten the center screw to 35-60 ft. lb. (45-75 N.m).



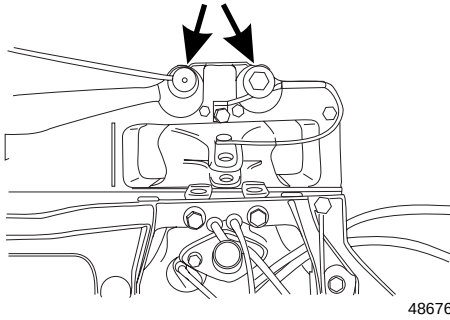
6. Apply 3M Adhesive sealant to the groove around the steering cavity, and install a new sealing ring.



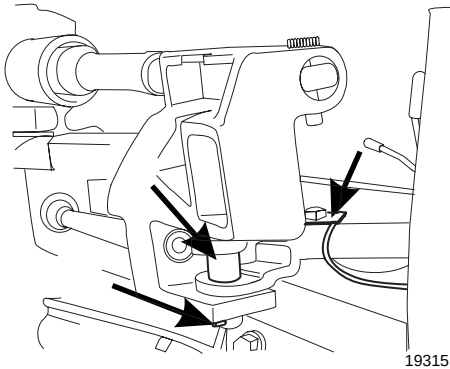
7. Remove the protective back off two new foam rubber seals and place them over the holes in the gimbal housing cover.



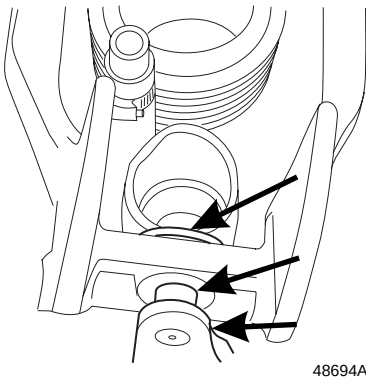
8. Set the gimbal housing cover in place. Install four mounting screws and tighten them to 60-84 in. lb. (7-9 N.m).



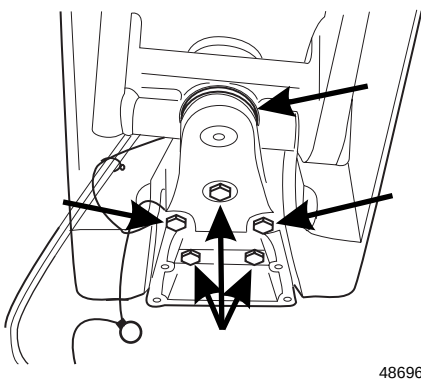
9. Apply *Volvo Penta Gasket Sealing Compound* to two screws. Install screws and washers and tighten them to 20-25 ft. lb. (27-34 N.m).



10. Attach ground wire to steering arm inside transom. **Apply Volvo Penta Grease P/N 828250 to large pin.** Pull hydraulic arm assembly over steering arm. Align holes and install large pin from top of arm. Install cotter pin. **Spread prongs** of cotter pin to secure large pin.



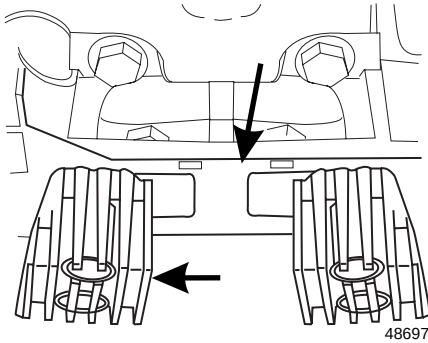
11. Apply *Volvo Penta Grease P/N 828250* to the nylon thrust washer and lower pivot post. Slide nylon washer between gimbal ring and gimbal housing. Align pivot post hole of the gimbal ring, gimbal housing, and thrust washer, then slide lower support bracket into position until it is seated.



12. Apply upward pressure to gimbal ring and support bracket. Use lower thrust washers as a gauge to determine how many will fit space between upper surface of support bracket and lower surface of gimbal ring.

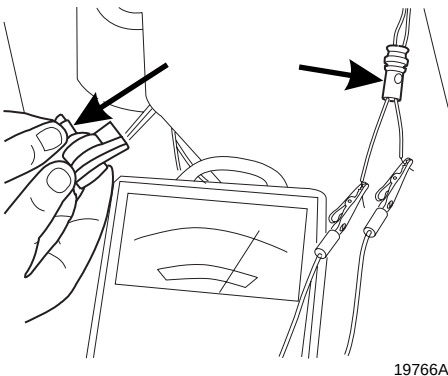
Note! The support bracket has a protruding lip on its upper surface where it fits over the pivot pin. When checking fit, washer insertion must be done at this point only, otherwise too many shims will be measured and installed. These washers will preload gimbal ring.

13. After determining number, add **one extra**, then install them in position. Use a minimum of one but no more than five washers to shim gimbal ring.
14. Apply *Volvo Penta Gasket Sealing Compound* to the five support bracket screws. Attach the trim cylinder ground wires to the two middle screws and install them. Screw in the remaining three remaining screws. Tighten all screws to 22-33 ft. lb. (30-46 N.m).

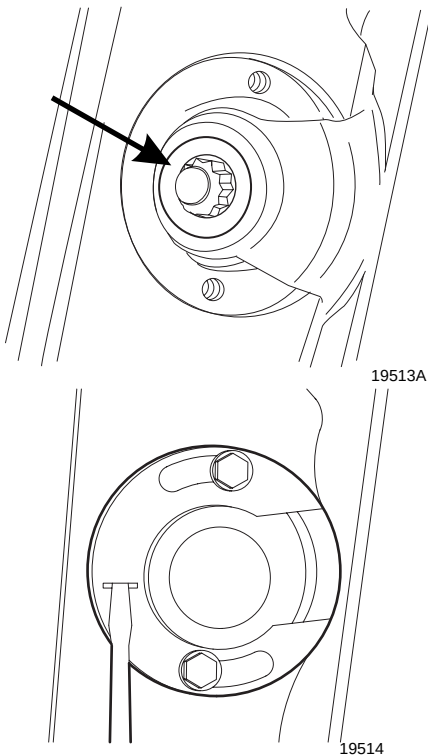


15. Position the anode and sensor housing and the two anodes. Install the four anode retaining screws and tighten to 5-7 ft. lb. (6-9 N.m).
16. **Install trim/tilt cylinders and pivot housing following instructions elsewhere in this section.**

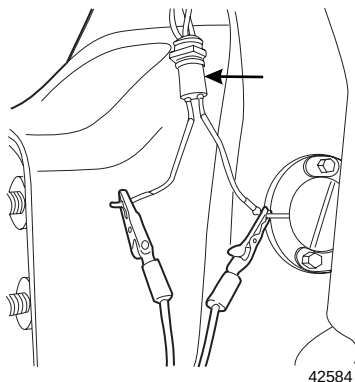
Trim Sender Adjustment



1. Connect an ohm meter to the sending unit connector. Turn the sending unit control nut until the meter reads 11 ± 1 ohm.

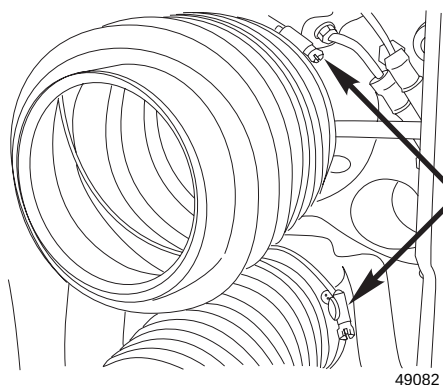


2. With lower edge of pivot housing pushed in towards the gimbal housing, insert sending unit control nut into pivot bolt head. Install two trim sender mounting screws finger tight so that the sender may be adjusted.



3. With the pivot housing pushed in towards the gimbal housing, check adjustment of sending unit between pins "A" and "C". Rotate sending unit to obtain a 11 ± 1 ohm reading on the meter, then tighten mounting screws to 18-24 in. lb. (2,0-2,7 N.m).

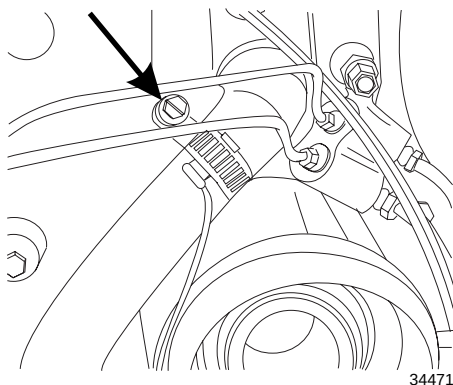
Gimbal Housing Disassembly



Remove trim/tilt cylinders, pivot housing, and gimbal ring following instructions elsewhere in this section.

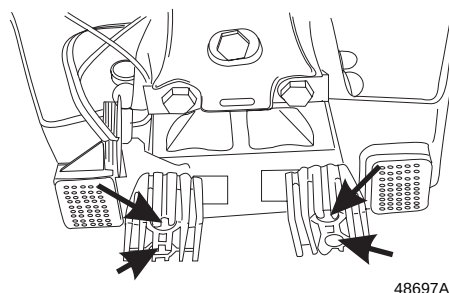
Water Hose and Bellows Removal

1. Unscrew clamps and pull off the U-joint and exhaust bellows.



2. Loosen clamp on upper end of water inlet hose and remove hose from water tube.

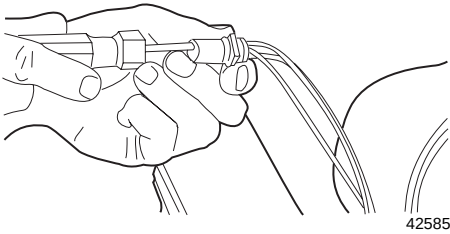
Anode Replacement



The sacrificial zinc anode need not be removed unless it's 2/3 deteriorated and needs to be replaced.

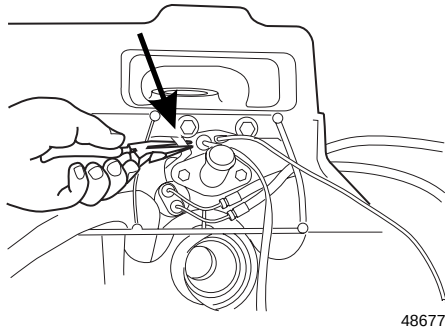
1. Remove the four screws and anodes.
2. Clean the mounting surface, then install the new anode and the attaching hardware. Tighten the screws to 5-7 ft. lb. (6-9 N.m).

Trim Sender Removal

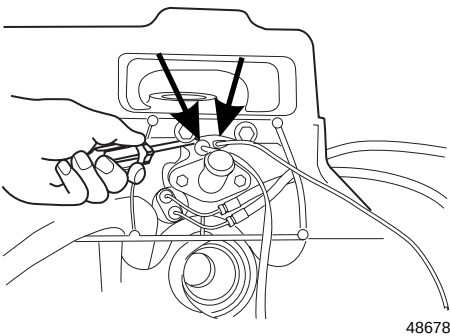


1. Disconnect rubber connector at wiring harness on engine. Record the position of the sending unit wires before removing. Use Socket Removal Tool, *Volvo Penta* P/N 3854350, to push terminals out of rubber plug.

Note! The use of alcohol will make socket installation into the rubber plug easier.



2. Remove the retaining clip from the grommet.

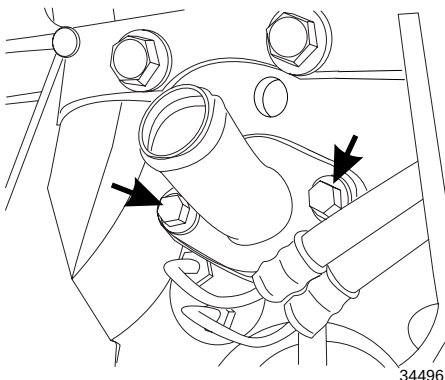


3. Push the grommet out with a screwdriver. Pull the wires through the hole, cut tie straps securing wires to the trim/tilt lines, and remove the trim sender.

Anode and Sensor Housing Removal

1. Disconnect the anode and sensor housing leads from the electronic control unit mounted on the inside transom.
2. Follow **Steps 2 and 3** above to remove the leads from the gimbal housing.

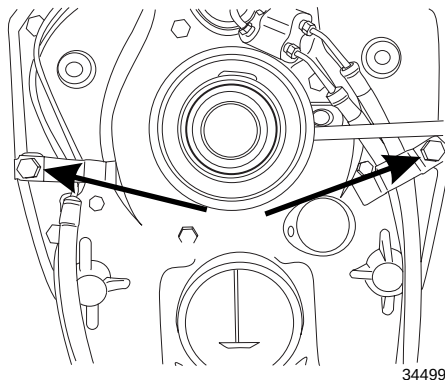
Water Tube Removal



1. Remove the two screws from the water tube retainer. Pull the water tube and grommet out of the gimbal housing. If the grommet sticks, go to the outside of the transom and push it through.
2. If the grommet needs to be replaced, slide it off the water tube. It can be reused if undamaged.

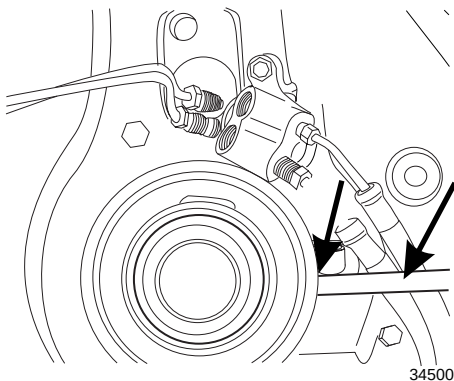
Hydraulic Lines and Manifold Removal

Remove the two clamps that secure the lines to each side of the gimbal housing.



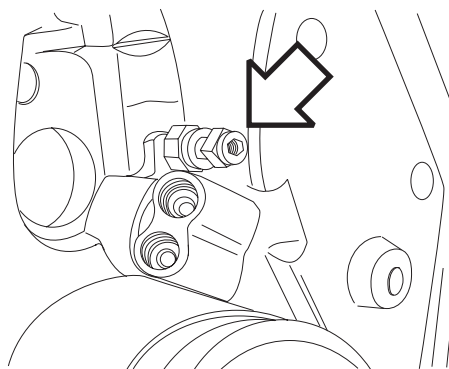
34499

3. Unscrew all four lines and remove them from the manifold. Remove and discard the fitting O-rings. Removal of the grease extension tube may make the servicing of the starboard side lines easier. Clamp a vise grip pliers close to the bearing bore and rotate the tube to loosen it. Pry against the plier head to force the tube out of the housing.



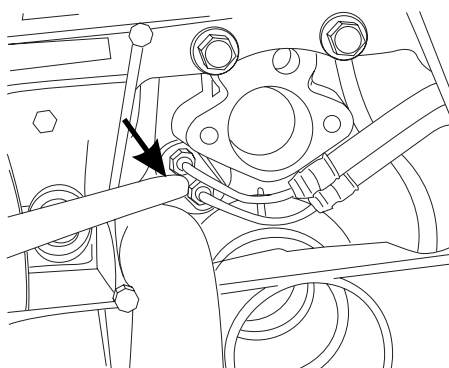
34500

4. Remove the locknut and washer that attach the manifold old to the housing. Since the manifold is sealed by an O-ring, use a small drift to drive it out of the housing from the inside of the boat.

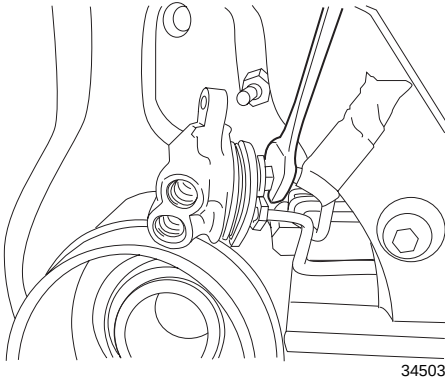


34501

5. Pull the manifold and lines through the hole as far as possible. Tag one line for reference and note their direction of routing.



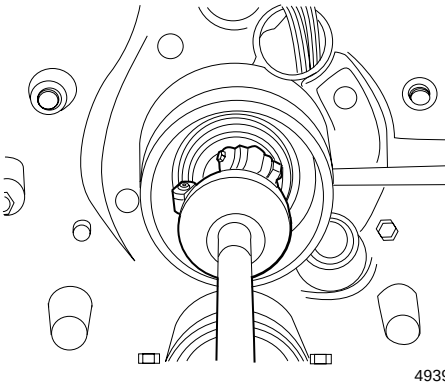
34502



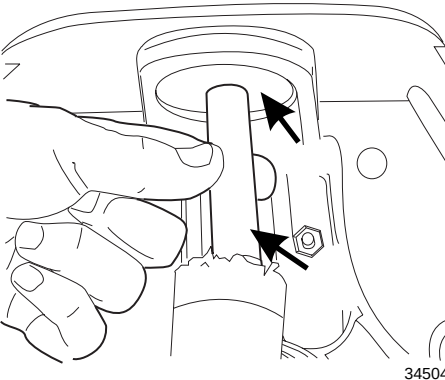
Steering Bearing, Gimbal Bearing and Seal Removal

6. Unscrew both lines, then discard the fitting O-rings. Remove the manifold O-ring and discard it.

Note! Do not remove the gimbal bearing or upper steering bearing unless they need to be replaced. Removal of the gimbal bearing and seal do not require disassembly of the transom bracket. Access can be gained by going through the U-joint bellows on an assembled transom bracket.



1. Use a three-jaw puller such as *Owatonna Tool*, P/N 1176, to pull out the gimbal housing bearing. Spread the tool jaws between the bearing and inner seal, and expand them tightly behind the bearing. Remove and discard the bearing.
2. Pull the inner seal out in a similar manner and discard it.



Gimbal Housing Cleaning and Inspection

3. Remove the thrust washer from around the top of the upper steering bearing. Use Installer, *Volvo Penta* P/N 3854360, and Driver, *Volvo Penta* P/N 3854356, to remove the bearing. Insert the driver into the installer and position the tool underneath the bearing as shown. Drive the bearing up and out of the bracket.

Clean grease and sealer from bearing cavity, seal seat, and manifold cavity. Check inner bore diameter for scoring or discoloration that indicates a spinning bearing.

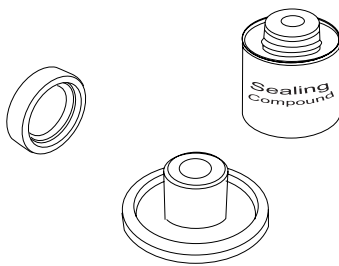
- **Pivot Bearing** - Inspect *Teflon* surface for wear or corrosion.
- **Gimbal Bearing** - Rollers must spin freely and hub must pivot in all directions; inner diameter must be free of corrosion.
- **Hydraulic Manifold** - O-ring groove must be free of nicks and burrs; all fluid passages must be clear.

- **Hydraulic Lines** must be clear and fittings undamaged.
- **Grease Fitting and Tube** - must be unobstructed.
- **Mounting Studs** - must be tight and have no thread damage.
- **Seal Grooves** - Check for corrosion, burrs and damaged edges.
- **Anode** - Check amount of deterioration. Clean parts in solvent and dry thoroughly.

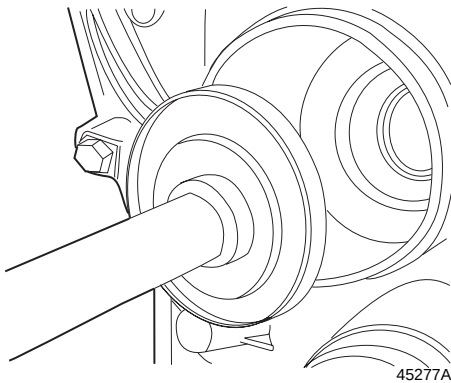
Some screw holes have special *Heli-Coil* inserts that provide a thread-locking feature. Do not clean *Heli-Coil* holes with a thread tap. This will damage the *Heli-Coil* inserts and force their replacement. Locking *Heli-Coils* are available only from *Volvo Penta Parts*. See your parts catalog.

Gimbal Housing Assembly

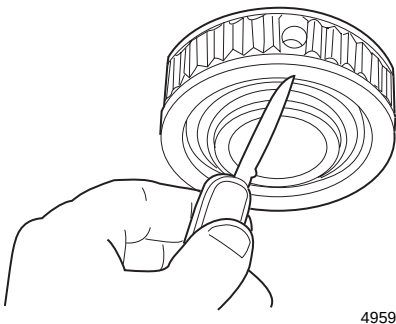
Steering Bearing, Gimbal Bearing and Seal Installation



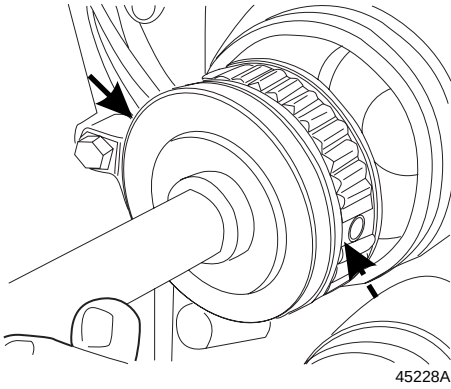
1. Face the open end of a new gimbal housing seal toward Installer, P/N 3850038, and place it on the projecting nose of the tool. Lightly coat the metal case with *Volvo Penta Gasket Sealing Compound*.



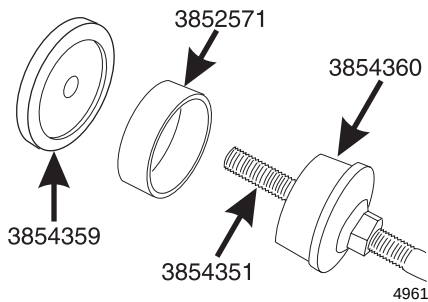
2. Screw the installer onto Drive Handle, *Volvo Penta* 3850609. Drive the seal into the housing until it seats. Coat the seal lip with *Volvo Penta Grease P/N 828250*.



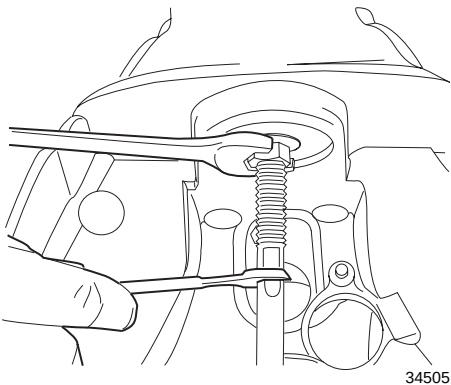
3. To ensure adequate lubrication of the gimbal bearing, it must be correctly positioned prior to installation. Rotate the outer band until its slot aligns with the lubrication hole. Scribe a reference mark at this point on the bearing case.



4. Screw the seal installation side of Installer, *Volvo Penta* P/N 3850038, onto Drive Handle, *Volvo Penta* P/N 3850609. Oil the exterior of the bearing case. Place the bearing with the reference mark facing the extension tube opening, onto the installer. Drive the bearing into the housing until it seats. Lubricate the bearing with grease or equivalent through the grease fitting on the starboard side of the housing.



5. To install the upper steering bearing, slide Installer, *Volvo Penta* P/N 3854360 onto Rod, *Volvo Penta* P/N 3854351 then place a new bearing on the installer. Lightly oil the outside of the bearing.
6. Installer, *Volvo Penta* P/N 3854359 will act as a stop to seat the bearing. When positioned inside the steering arm cavity, the recessed side of the tool must face the bearing as shown.

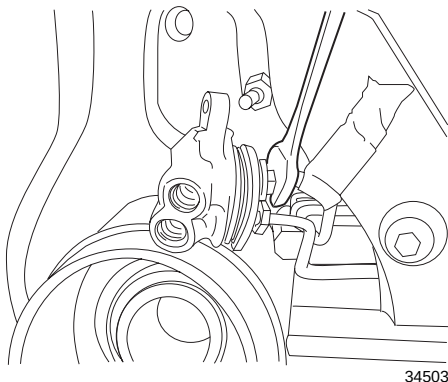


7. Face recessed side of Installer, *Volvo Penta* P/N 3854359 down and insert it into the steering arm cavity from inside the boat. Screw puller rod into the installer until it's flush with the top of the installer. Hold the rod and tighten the nut until the bearing seats.

Hydraulic Lines and Manifold Installation



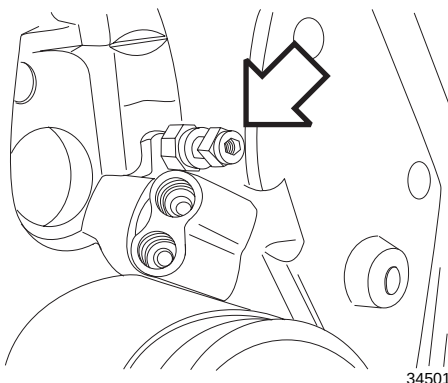
1. Coat a new O-ring with *Volvo Penta* Gasket Sealing Compound and place it on the manifold.
2. Lubricate two new O-rings with hydraulic fluid and place them on the hydraulic line tips.



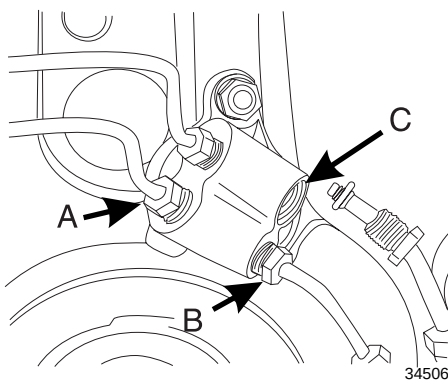
3. Hold the manifold as shown and attach the lines. Make sure the tagged line goes in its proper location. Route both lines parallel and at the angle shown. Line routing is important otherwise manifold will be difficult or impossible to install. Tighten the fittings to 84-108 in. lb. (9,5-12,2 N.m) and discard the reference tag.



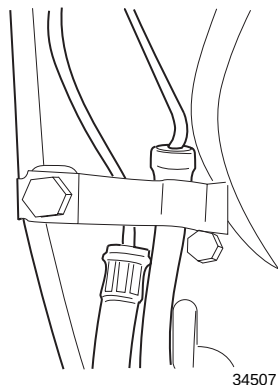
Tagged line must attach to the correct inlet. If lines are switched, trim/tilt mechanism will malfunction. When properly connected, the lower manifold line will attach to the “UP” inlet on the pump valve body, and the upper manifold line will connect to the starboard inlet on the pump body.



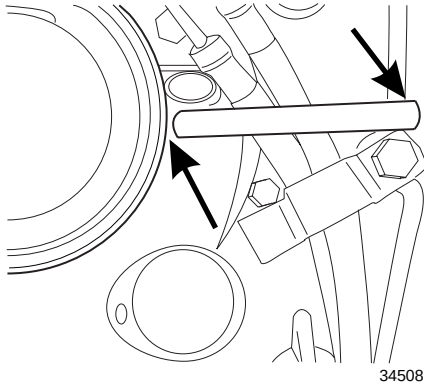
4. Feed the lines through the manifold opening, pulling them from inside the transom if necessary. Seat the manifold over its mounting stud. Use a new locknut and tighten nut to 108-132 in. lb. (12-15 N.m).



5. Coat new O-rings with hydraulic fluid and place them on hydraulic lines. Attach the lower port line (A) to the manifold first, then the upper one. Tighten the fittings to 84-108 in. lb. (9,5-12,2 N.m). Attach the short starboard line to the lower port (B) of the manifold. Attach the long starboard line to the upper port (C) of the manifold. Tighten the fittings to 84-108 in. lb. (9,5-12,2 N.m).

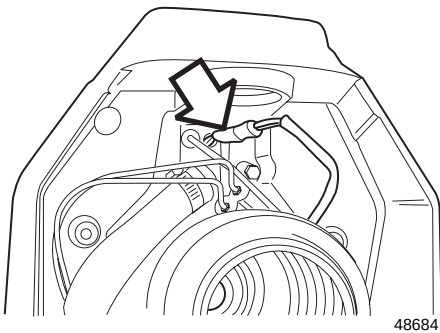


6. Route the lines together down the side of the housing. Install the clamp and screw, tighten the screw securely.

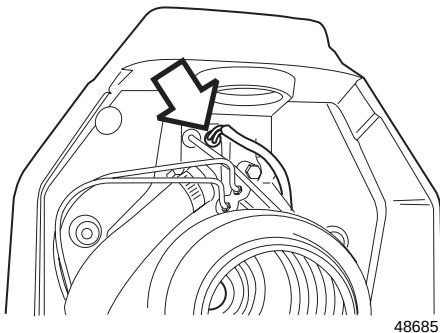


7. If the grease extension tube was removed, install it as follows:
 - a. Remove the grease fitting from the tube. Apply *Volvo Penta Gasket Sealing Compound* to the last 1/4 in. of the grease fitting end of the tube. Insert the tube through the outer wall of the housing.
 - b. Spray the tapered end of the tube and housing hole with *Loctite Primer* or equivalent and allow to air dry.
 - c. Sparingly apply *Volvo Penta Thread locking compound P/N 1161053* to the tapered end of the tube and drive the tube into the housing until it seats. Wipe away any excess adhesive that may enter the bearing cavity or the end of the tube. Install the grease fitting.

Trim Sender Installation

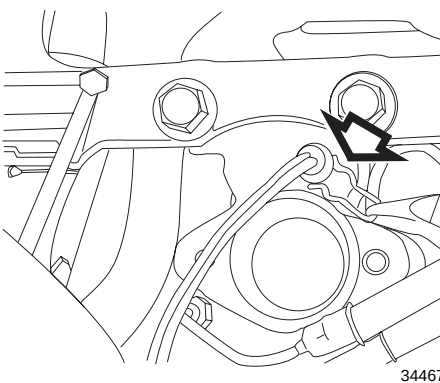


1. Apply *Volvo Penta Grease P/N 828250* to the trim/tilt sender lead grommet. Feed the wires through the opening in the rear of the gimbal housing, and out through the transom plate.

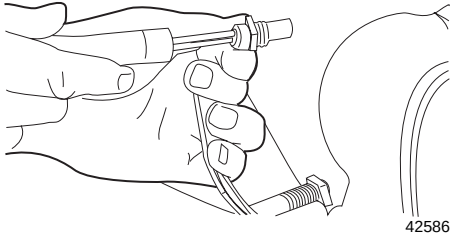


2. Push the grommet into the hole until it seats.

Note! Do not route trim/tilt sender leads under extension tube or hydraulic lines. Leads must be free to move when drive unit steers, otherwise sender or wire will be damaged.



3. Attach the retaining clip to the grommet inside the transom plate.



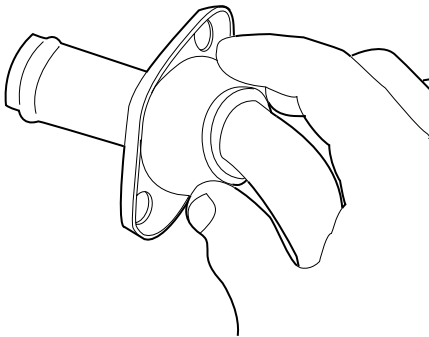
4. Install the RIBBED BLACK wire in the "A" terminal, the WHITE wire in the "B" terminal and SMOOTH BLACK wire in the "C" terminal on the *Amphenol* connector. Use Socket Installer, *Volvo Penta* P/N 3854349 to push the wire sockets into the rubber plug until they seat.

Note! The use of alcohol will make socket installation into the rubber plug easier.

Anode and Sensor Housing Installation

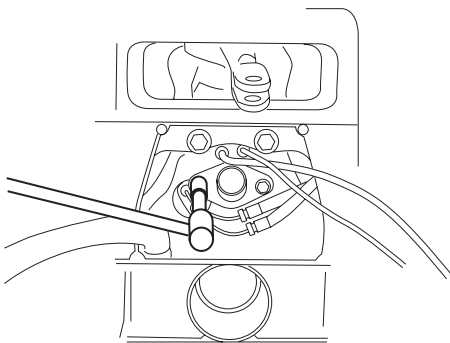
1. Install the anode and sensor lead into the gimbal housing following **Steps 1 and 2** above.
2. Connect the anode and sensor leads to the electronic control unit mounted on the inside transom.

Water Tube Installation



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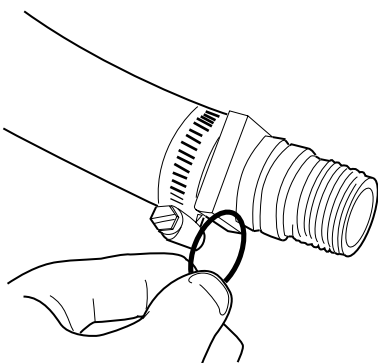
1. If the grommet was discarded, face the tapered end of a new one toward the hooked end of the tube and slide it up against the flange.



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2. From inside the boat, insert the hooked end of the tube through the gimbal housing. Hold the tube vertically, then install the two mounting screws and tighten them to 120-144 in. lb. (14-16 N.m).

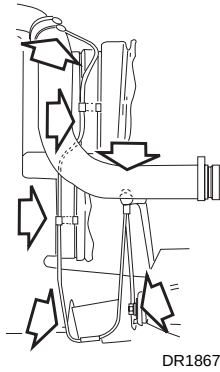
Water Hose Installation



6227

1. Remove and discard the nipple O-ring. Clean all grease from the nipple making sure the drain hole is clear. If the nipple needs to be replaced, remove the clamp and pull it out of the hose. Install a new nipple and secure with a clamp. Tighten the clamp securely.
2. Coat a new O-ring with *Volvo Penta Grease P/N 828250*. Slide it onto the nipple and position it in the groove closest to the square at the end of the fitting. Clean excess grease out of drain hole and drain groove.

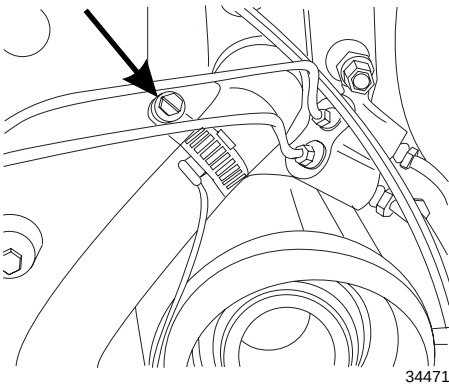
Note! Do not place an O-ring in the drain hole groove. This would prevent water draining out during winterization, and could result in freeze damage.



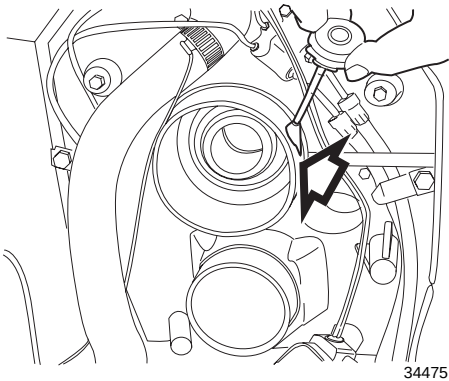
3. Slide a clamp onto the upper end of the hose. Position the screw head so that it will be behind the port hydraulic lines as shown. Push the hose onto the water tube, then rotate it until the nipple points directly outward. Slide the ground strap clip under the hose clamp. Tighten the clamp securely.

Note! Clamp's screw head must be behind hydraulic lines to prevent it contacting the pivot housing when drive is in a full tilt position. Improper clamp position may limit tilt range, and damage clamp and hose.

4. Check the position of the nipple drain hole. If it's not facing down, loosen the nipple clamp and rotate nipple until the drain hole is facing down. Tighten clamp securely.

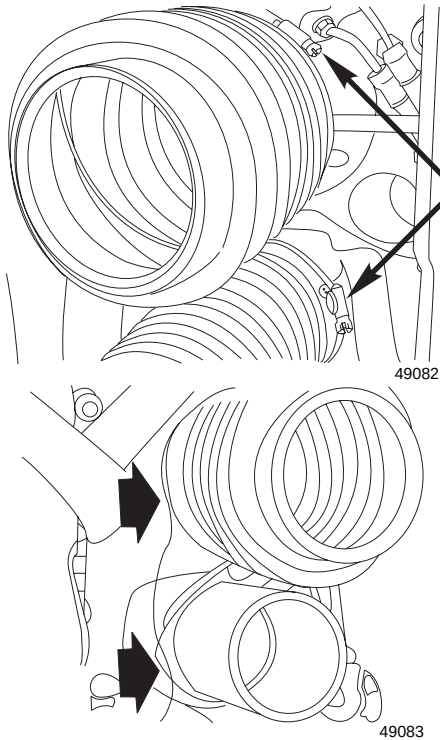


U-joint and Exhaust Bellows Installation



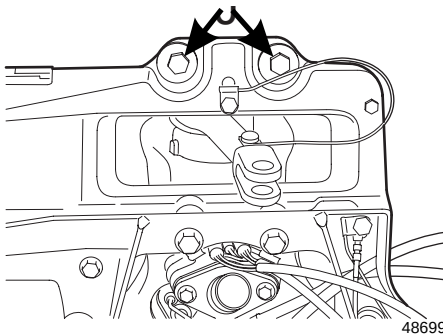
1. Coat the outside surface of the gimbal bearing bore with *Volvo Penta Gasket Sealing Compound*. Sealer is not required on the outside of the exhaust opening.

Note! Clamp's screw position is important. If not properly positioned, steering radius will be reduced because of gimbal ring contacting clamp head when turning.



2. Place clamp on the small end of the U-joint bellows. There is an internal rib that must engage a corresponding groove around the opening's surface. Push the bellows on and engage the groove, then rotate the clamp until the screw fitting is in the one or two o'clock position. Slide ground strap clip under hose clamp. Tighten the clamp securely.
3. The large end of the exhaust bellows has an internal rib similar to the U-joint bellows. Place clamp on this end. Bellows must be positioned with exhaust relief cutout facing down. Push the bellows onto the exhaust tube until it engages the groove. Turn the clamp screw to the three o'clock position. Slide ground strap clip under hose clamp and tighten the clamp securely.
4. Install gimbal ring see Gimbal Ring Installation on page 66, trim/tilt cylinders see Trim/Tilt Cylinder Installation on page 56, and pivot housing see Pivot Housing Installation on page 60.

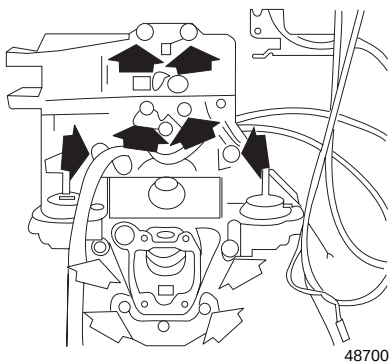
Gimbal Housing and Transom Plate Removal



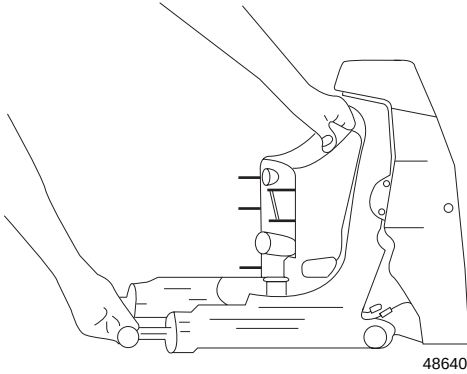
Remove engine, lower exhaust pipe and steering cylinder following instructions found in *Engine and Sterndrive Installation Manual*.

Note! The transom bracket assembly can be removed without complete disassembly. Since the gimbal housing is attached to the trim lines and pump, decide whether to disconnect trim lines at hydraulic manifold after inner transom plate is removed, or to unscrew trim pump from transom and feed pump and lines through cutout as gimbal housing is removed.

1. Remove the screw and washer securing the transom plate ground strap to the steering arm.
2. Remove the two screws and four nuts and washers securing the transom plate inside the boat. Lift the plate off the studs. Note that the hydraulic lines route above the uppermost port stud and through a relief in the inner transom plate.

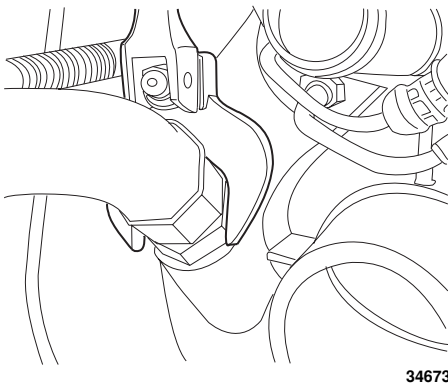


3. Remove the two remaining nuts, washers, and transom bearing plate. Pull the gimbal housing off the transom.



Shift Cable Sleeve Replacement

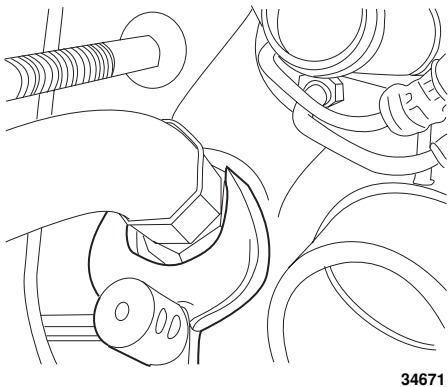
1. Unscrew the shift cable sleeve and connector assembly. Discard the connector O-ring.



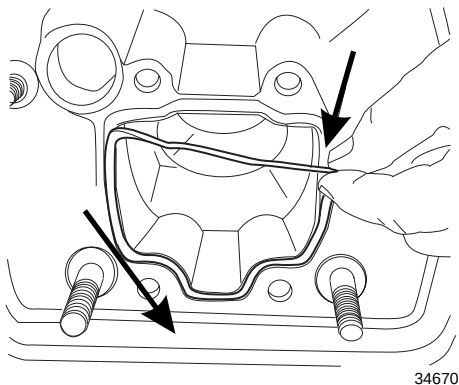
2. Apply *Volvo Penta Gasket Sealing Compound* to a new O-ring. Slide it onto the connector and position it against the hex then coat the connector threads with sealer.



3. Install the sleeve and connector assembly, and use a crowfoot adapter to tighten the connector to 40-45 ft. lb. (54-61 N.m).

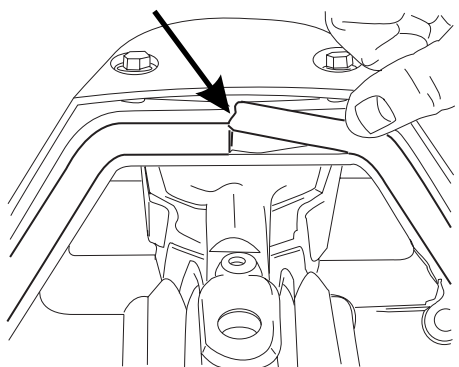


Transom and Exhaust Seal Replacement



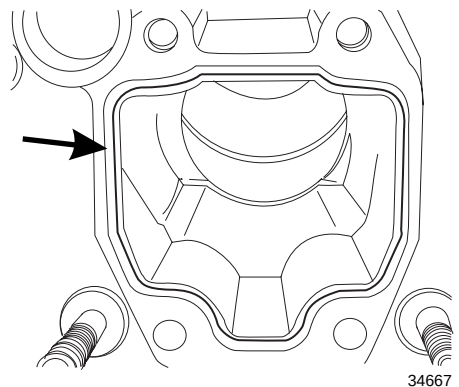
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1. Remove and discard the exhaust O-ring seal and the large rubber transom seal.



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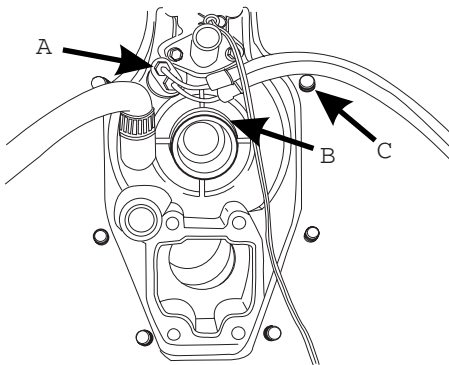
2. Apply 3M Scotch Grip Rubber Adhesive 1300 to the entire transom seal groove around the gimbal housing. Start at top and firmly push a new seal into the groove. Also apply 3M Scotch Grip Rubber Adhesive 1300 to the seal ends and butt them together to form a watertight junction at the top of the gimbal housing.



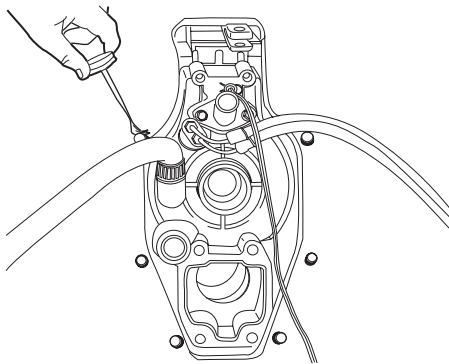
34667

3. Apply 3M Scotch Grip Rubber Adhesive 1300 in the exhaust groove, and install a new O-ring seal.
4. Remove the protective back off two new foam rubber seals and place them over the holes in the gimbal housing cover.

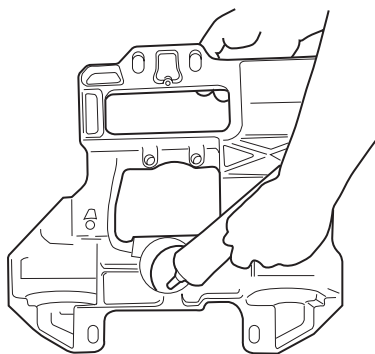
Gimbal Housing and Transom Plate Installation



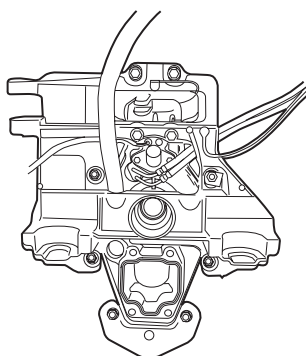
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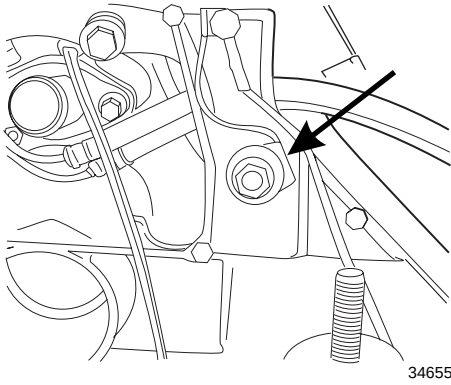


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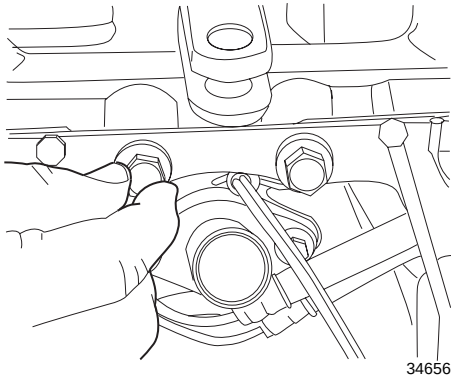


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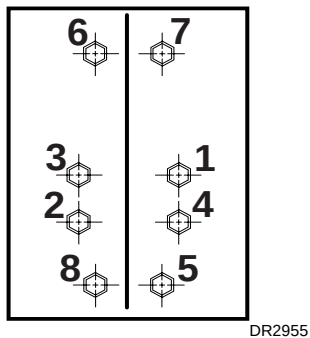
1. Thoroughly clean outer transom surface where gimbal housing seal makes contact. If trim pump and lines are already attached to housing, insert them through transom cutout, then install gimbal housing. Do not use sealer between housing seal and transom, and do not attach washers or nuts at this time.
2. If trim lines were previously disconnected, attach them to the hydraulic manifold (A). **Note: Line from pump “UP” outlet must attach to lower manifold opening, otherwise trim system will not function properly.** Route the lines above the alignment tube (B) and over the uppermost port stud (C) as shown.
3. Lightly coat the six gimbal housing studs with *Volvo Penta Gasket Sealing Compound*.
4. Apply a light coat of *Volvo Penta Grease P/N 828250* to the inside of the transom plate alignment tube.
5. Position the two hydraulic lines above the uppermost port stud and mount the transom plate. Place the transom bearing plate over the two bottom studs, flat side against transom. Install three flat washers, five new locknuts. Lightly coat the threads of the two long screws with *Volvo Penta Gasket Sealing Compound*. Thread the two long screws and two flat washers into the top holes of the transom plate. Tighten nuts and screws until they just contact plate and transom. **Do not tighten nuts and screws at this time.**



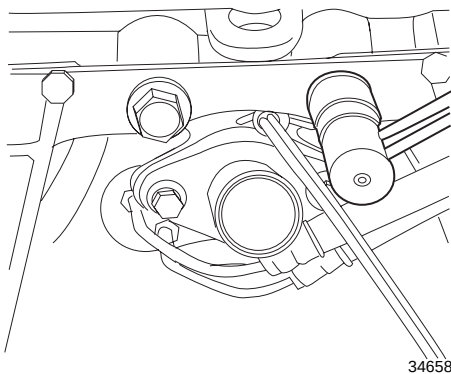
6. Position ground wire on transom bracket stud. Install washer and locknut. **Do not tighten nut at this time.**



7. Lightly coat the alignment screw threads with *Volvo Penta Gasket Sealing Compound*, then screw them completely in only finger tight. **Do not tighten the alignment screws** at this time.

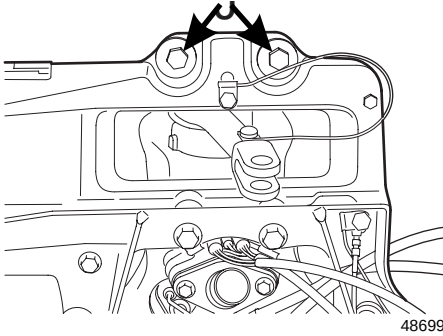


8. Tighten the six locknuts in a cross pattern, starting with the two center nuts. Tighten them to of 20-25 ft. lb. (27-34 N.m).



9. Tighten the two alignment screws to 12-14 ft. lb. (16-19 N.m).

10. Attach transom plate ground strap to the steering arm and secure with screw and washer. Tighten screw securely.



Torque Specifications

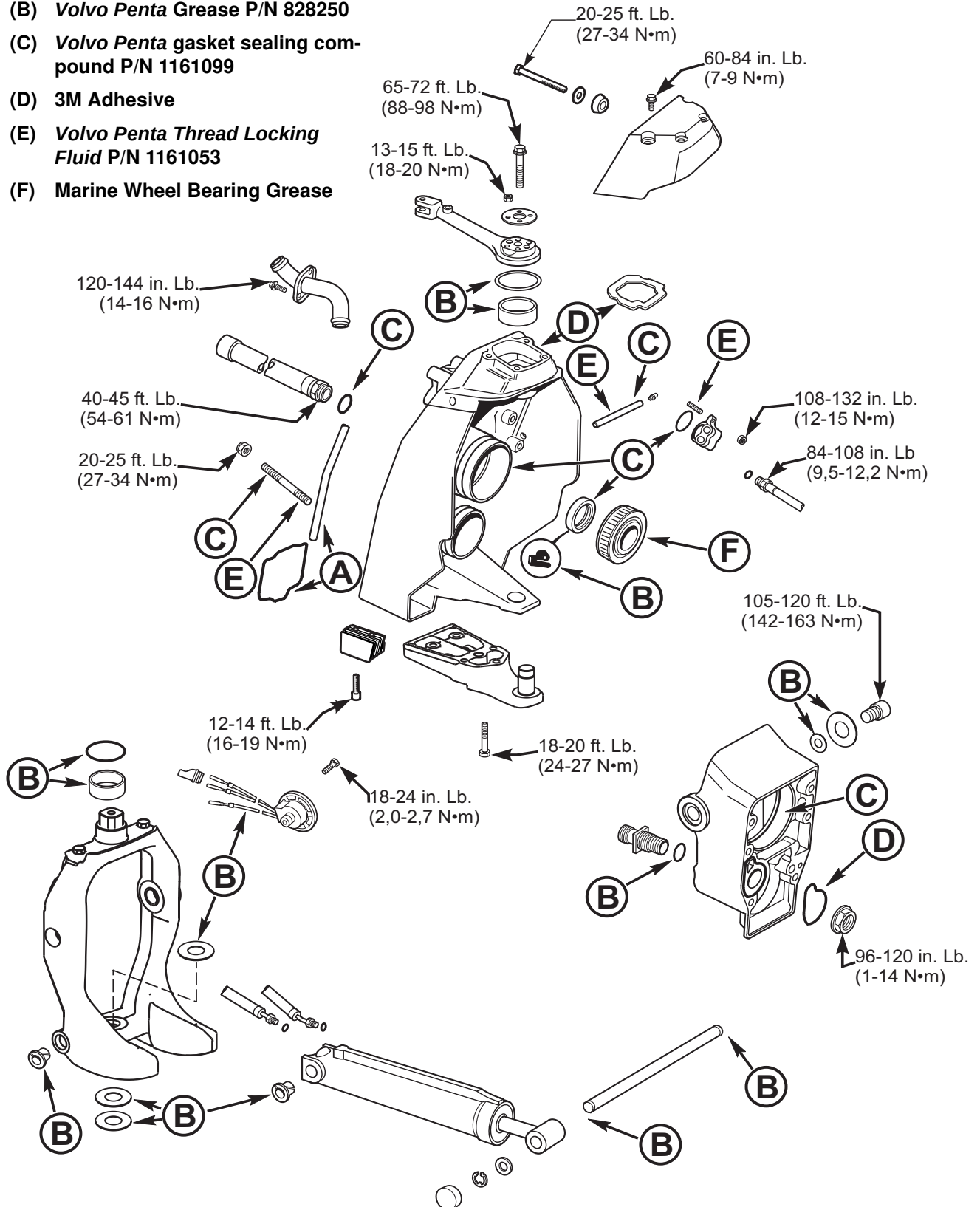
Torque		
Description	U.S.	Metric
Nut		
Manifold to Transom Bracket	108-132 in. lb.	12-15 N•m
Shift Cable Sleeve	40-45 ft. lb.	54-61 N•m
Transom Bracket Mounting	20-25 ft. lb.	27-34 N•m
Trim Line to Cylinder/Manifold	84-108 in. lb.	9,5-12,2 N•m
Water Nipple	96-120 in. lb.	11-14 N•m
Screw		
Alignment, Inner Transom Plate	12-14 ft. lb.	16-19 N•m
Anode	5-7 ft. lb.	6-9 N•m
Cover, Gimbal Housing	60-84 in. lb.	7-9 N•m
Gimbal Ring Support - Large screw	38-59 ft. lb.	51-81 N•m
Gimbal Ring Support - Small screw	13-28 ft. lb.	18-38 N•m
Pivot Housing to Gimbal Ring	105-120 ft. lb.	142-163 N•m
Steering Arm, Center	35-60 ft. lb.	45-75 N•m
Support Bracket, Gimbal Ring	22-33 ft. lb.	30-46 N•m
Transom Bracket Mounting	20-25 ft. lb.	27-34 N•m
Trim Sender	18-24 in. lb.	2,0-2,7 N•m
Water Outlet	120-144 in. lb.	14-16 N•m

Sealants Lubricants, Adhesives

Adhesives	
Volvo Penta Thread Locking Compound P/N 1161053	Stud, Gimbal Housing Lubrication Tube Stud, Manifold
3M Adhesive	Seal, Water Passage Seal Ring, Gimbal Housing Cover
3M Scotch Grip Rubber Adhesive 1300	Seal, Exhaust Opening Transom Seal
Lubricants	
Volvo Penta Grease P/N 828250	Alignment Tube, Inner Transom Plate Bushing, Upper Steering Post Friction Washer, Pivot Housing Grommet, Trim Sender Lead Nylon Bushing, Trim Cylinder O-ring, Upper Steering Post O-ring, Water Nipple Pivot Pin, Trim/Tilt Cylinder Seal Lip, Gimbal Housing Thrust Washer, Lower Steering Post Thrust Washer, Pivot Bolt Thrust Washer, Upper Steering Bearing
Marine Wheel Bearing Grease	Gimbal Bearing, Driveshaft
Sealants	
Volvo Penta Gasket Sealing Compound P/N 1161099	Alignment Screw, Transom Plate Gimbal Housing Lip, U-joint Bellows Lubrication Tube O-ring, Hydraulic Manifold O-ring, Shift Cable Tube Pivot Housing Lip, U-joint Bellows Pivot Pin Threads, Trim/Tilt Seal Case, Gimbal Housing Studs, Gimbal Housing

Service Chart

- (A) 3M Scotch Grip rubber adhesive 1300
- (B) Volvo Penta Grease P/N 828250
- (C) Volvo Penta gasket sealing compound P/N 1161099
- (D) 3M Adhesive
- (E) Volvo Penta Thread Locking Fluid P/N 1161053
- (F) Marine Wheel Bearing Grease



DRC7453

Notes

Upper Gear Housing

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Safety Warnings Before beginning work in this section, read Safety chapter at end of this manual. When replacement parts are required, use genuine *Volvo Penta*. Failure to do so may result in product malfunction and possible injury to the operator and/or passengers. Several of the following procedures require use of an arbor or hydraulic press. Always wear safety glasses when using this device to perform these procedures.

Special Tools

Tool Name	Volvo Penta P/N	Panel Location
Assembly Tool	884932	F
Bracket Assembly	3850057	J
Disassembly Tool	884933	F
Drift	884168	F
Drift	884259	F
Drift	884263	F
Drift	884266	F
Remover/Installer	3850606	H
Retaining Ring Pliers	3850608	B
Seal Installer	3850607	H
Shim Tool	3850600	H
Shim Tool	3850701	H
Sleeve	884938	F
Spanner Wrench	3850604	H
Spline Socket	3850598	H
Standard Shaft	9991801	H
universal joint Adaptor Kit	3850628	G
Upper Gear Housing Holder	3856163	**

** Not located on tool board because of size.

Owatonna Service Tools

OEM 4635 universal joint Tool
OEM 1027 Universal Dial Indicator Set

Order From:

OTC Division of SPX Corporation
655 Eisenhower Drive
Owatonna, Minnesota 55060 USA
Toll free order line: 1-800-533-0492 or 1-800-533-5338
<http://www.otctools.com>

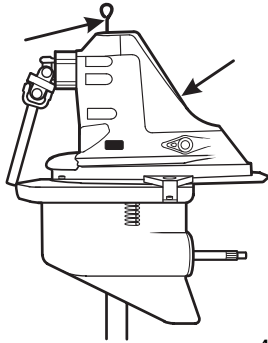
Sealants, Lubricants and Adhesives

Cleaning Solvent
GL5 Synthetic gear lubricant
Volvo Penta Gasket Sealing Compound
Loctite Primer
Volvo Penta Thread locking compound P/N 1161053
Volvo Penta Grease P/N 828250
3M Adhesive
Wheel Bearing Grease gear lubricant

Sterndrive Removal

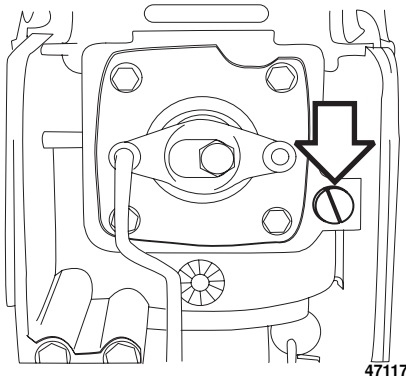
To service components of the upper gear housing, remove sterndrive from transom bracket. Follow the procedure in **Sterndrive Removal and Installation** section in this manual.

Sterndrive Disassembly



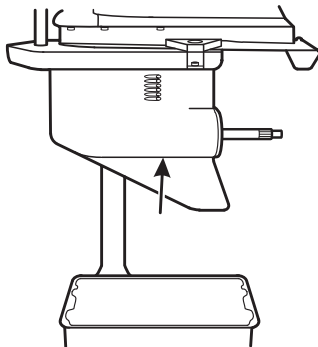
42587

1. Mount the sterndrive assembly in a suitable holding fixture and clamp it securely. Unscrew the lifting eye, if one was used, or the dipstick. Discard the O-ring on the dipstick.



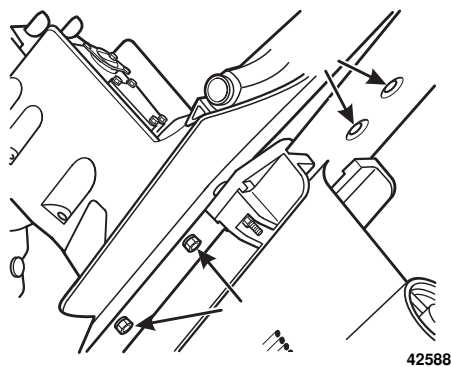
47117

2. Remove the rear plastic cover, if it hasn't been removed. ed. Remove the oil level plug so the oil reservoir vents when draining. Discard the O-ring.



34645

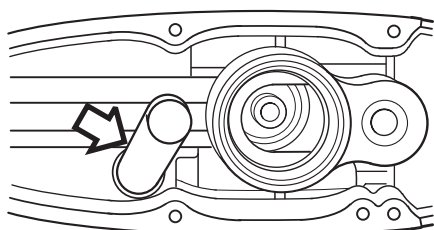
3. Place a 4 quart drain pan under the lower gear case. Remove the lower drain plug, discard the O-ring, and let the sterndrive drain completely.



4. Remove six screws, two on either side, and two aft. Remove the upper gear housing.

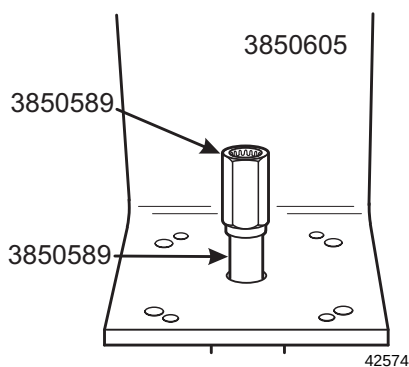
Upper Gear Housing Disassembly

1. Remove the water tube and grommet from the upper housing. Discard the grommet.



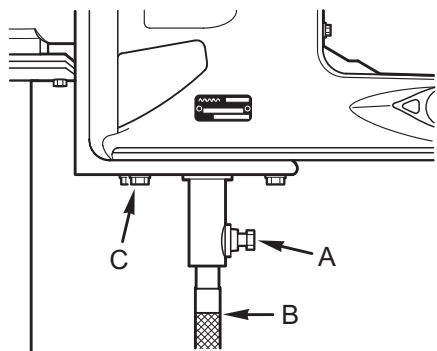
39389

2. Attach Spline Socket, *Volvo Penta* P/N 3850598 to the Upper Gear Housing Holder, *Volvo Penta* P/N 3856163. Tighten the set screw securely.

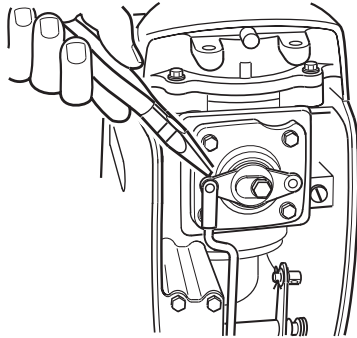


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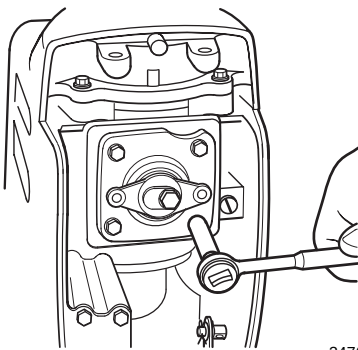
3. Mount the upper gear housing on the holding fixture. Loosen locking screw (A). Rotate and lift fixture shaft (B) to engage housing upper driveshaft splines. Install and securely tighten the four mounting screws (C).



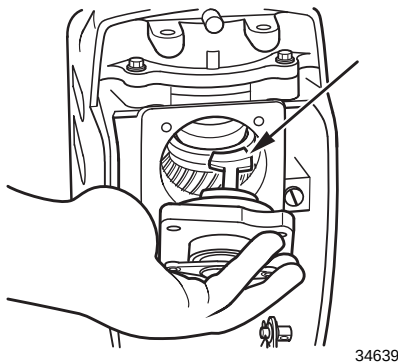
42576

Shift Actuator Housing Removal

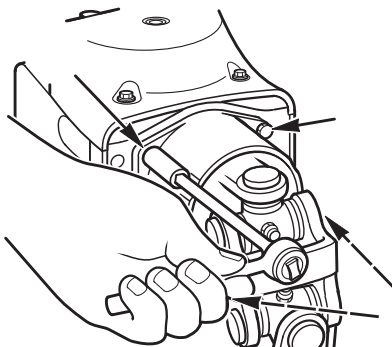
1. Remove cotter pin and washer retaining shift link to eccentric piston arm. Move shift link out of the way.



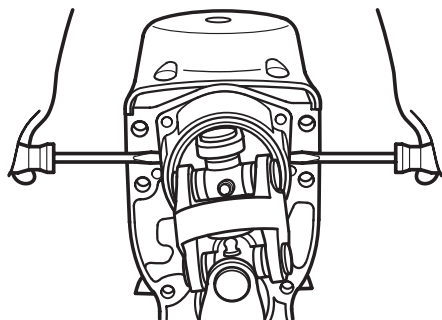
2. Remove four screws securing shift actuator housing. Remove the housing from the upper gear housing.



3. Note the position of the shift shoe during removal. It must be properly positioned during installation or the shift system will not function correctly.

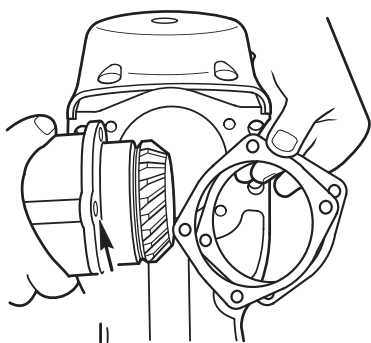
Pinion Bearing Carrier Removal

1. Remove the four screws securing the pinion bearing carrier to the upper housing.



34603

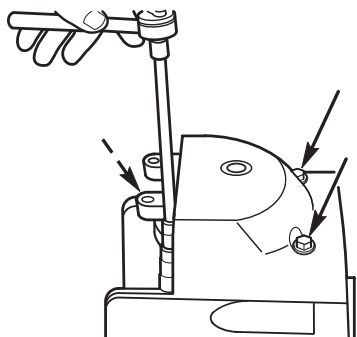
2. Remove the pinion bearing carrier using two screwdrivers. Be careful not to damage the upper housing or the bearing carrier mounting surfaces.



34604

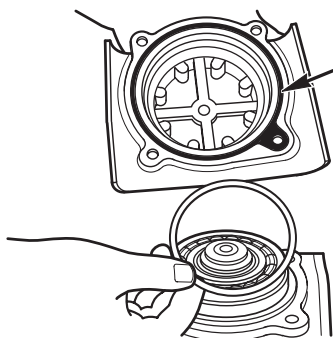
3. Save any undamaged plastic shims, as they may be reused. Remove and discard the O-ring.

Output Gear Removal



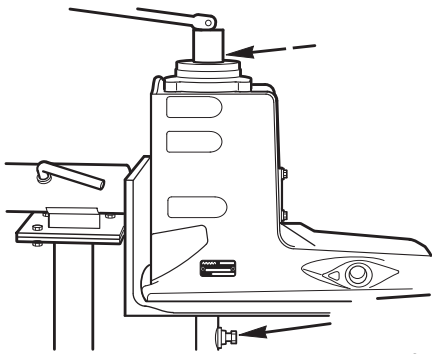
34605

1. Remove the four screws securing the upper gear housing top cover. Remove the cover.



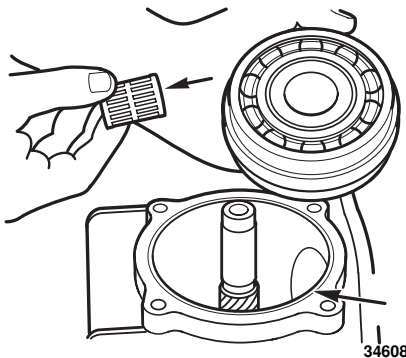
34606

2. Save any undamaged shims under the cover as they may be reused. Remove and discard the cover seal.



42577

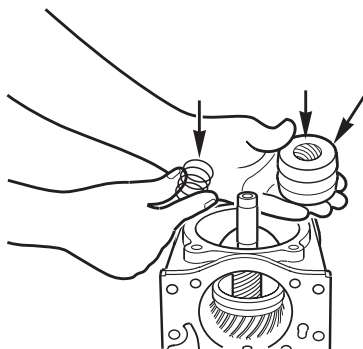
3. Push the holding fixture shaft up to engage the upper driveshaft splines. Align the flat on the fixture shaft with the locking screw. Tighten the locking screw to prevent the upper gear housing shaft from turning. Remove the **LEFT-HAND** threaded nut on top of the shaft with a 30 mm socket.



34608

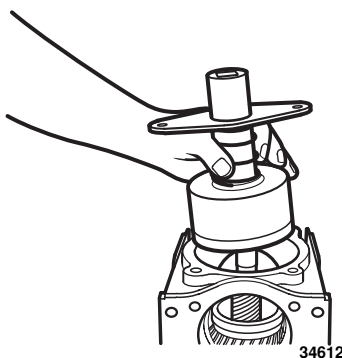
4. Lift upper gear and bearing assembly out of the housing. Remove needle bearings from center of bearing assembly after noting bearing orientation (top-to-bottom). Remove and save shims. They can be reused if they are not damaged.

Note! Do not mix needle bearings with those of the lower gear and bearing assembly. Premature failure will result if they are intermixed. Bearings should be reinstalled in the same top-to-bottom orientation as they were removed for longevity.



34611

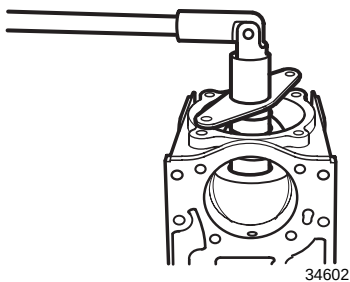
5. Remove cone clutch and spring. Note the word "**TOP**" on the top side of the cone clutch. This must face up during reassembly.



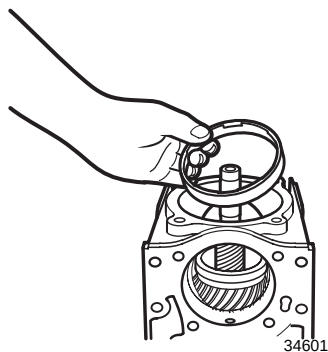
34612

6. Use Spanner Wrench, *Volvo Penta* P/N 3850604-4 to unscrew the bearing retainer ring that holds the lower gear and bearing assembly in place. Insert the tool into the housing. Use two upper gear housing cover screws to secure the spring loaded arm to the top of the gear housing. As the screws are turned down, alternate between the two screws every two turns. Seat the screws completely, then tighten them securely.

Note! Tighten the holding fixture securely. The bearing retainer ring is tightened to 145-165 ft. lb. (197-224 N.m).

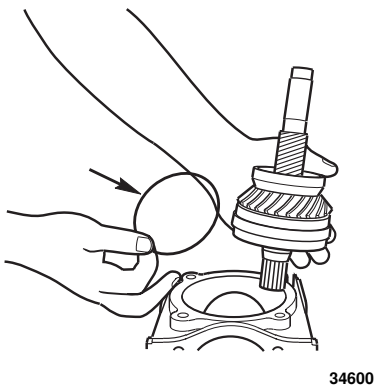


7. Attach a 3/4 in. breaker bar to the spanner tool and break the retainer ring free.

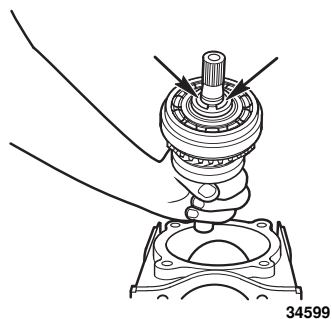


8. After it turns easily, detach the spring-loaded arm from the top of the housing. Unscrew the retainer ring and lift it out.

Note! Be careful removing the screws. The arm is under tension.

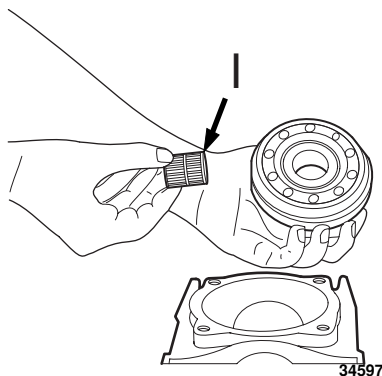
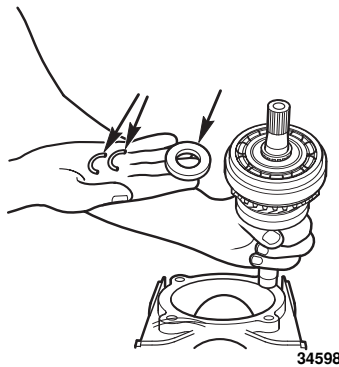


9. Remove the lower bearing and shaft assembly. Remove the shims at the bottom of the housing. The shims can be reused if undamaged.



10. Turn the lower bearing and shaft assembly over. Push up on shaft to disengage upper driveshaft C-clips from ring spacer.

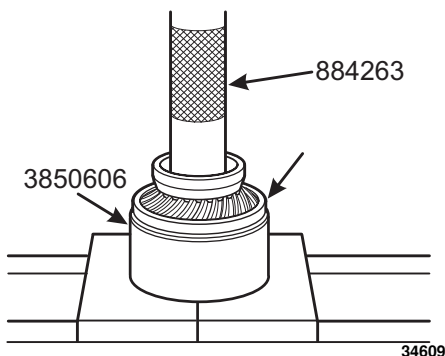
11. Remove the upper driveshaft C-clips and ring spacer from the shaft.



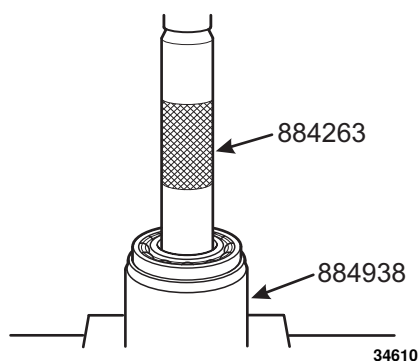
12. Remove lower gear and bearing assembly. Remove needle bearings from the assembly after noting bearing orientation (top-to-bottom).

Note! Do not mix needle bearings with those of the upper gear and bearing assembly. Premature failure will result if they are intermixed. Bearings should be reinstalled in the same top-to-bottom orientation as they were removed for longevity.

Upper and Lower Output Gear Disassembly

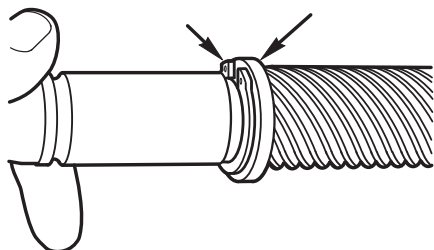


1. Place Remover/Installer, *Volvo Penta* P/N 3850606-9, large diameter end up, in a press. Place the upper gear and bearing assembly (has extra ring around bearing) into the tool with the gear facing up. Press the ring off the bearing using Drift, *Volvo Penta* P/N 884263-5.



2. Place Sleeve, *Volvo Penta* P/N 884938-2, large diameter end up, in a press. Place the upper bearing assembly into the tool with the gear facing down. Press the gear from the bearing using Drift, *Volvo Penta* P/N 884263-5.
3. Follow the procedures in the previous step and remove the lower gear from the bearing.

4. **Wear eye protection.** The upper driveshaft may be disassembled if needed, by removing the spring C-clip and spring spacer.



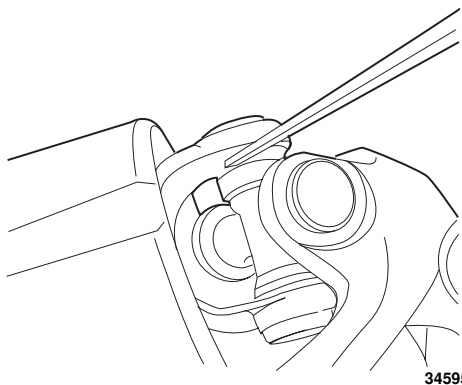
34596

Universal Joint Replacement

Note! Both Universal Jointuniversal joints can be replaced without removing the pinion bearing carrier from the upper gear housing.

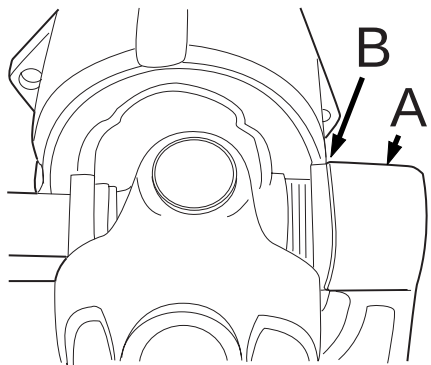
Removal

1. **Wear eye protection.** On the inside of each Universal Joint arm is a retaining ring. Use a small drift and mallet to remove all eight retaining rings. Discard the old retaining rings and replace them with new ones.

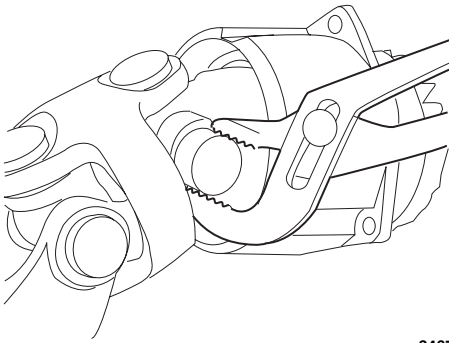


34595

2. Remove the Universal Joints requiring replacement. Press out the Ujoints with *Owatonna* Tool, P/N 7068, or equivalent. Pilot the bearing cap with open adaptor from Universal Joint Kit, *Volvo Penta* P/N 3850628. Follow the instructions provided by the tool manufacturer.

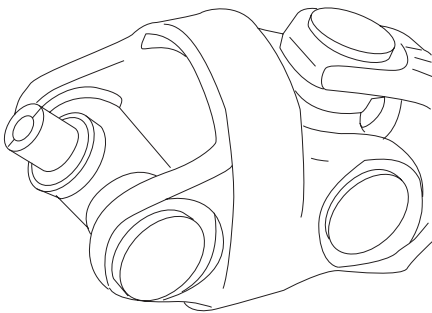


34594



34673

3. Do not press any bearing cap completely through its yoke. When the pressure-side cap is almost through the yoke, remove the Universal Joint shaft from the tool and pull off the exposed cap with pliers. Rotate the Universal Joint 180° and press the cross bar in the opposite direction to remove the remaining cap.



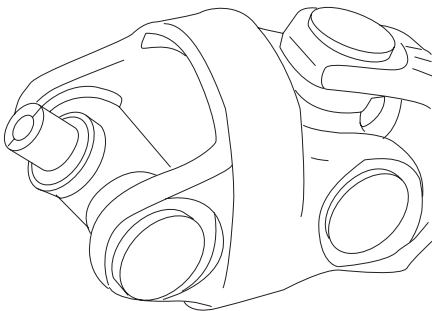
34636

4. Remove the remaining caps and other Universal Joint using the *Owatonna* tool as previously described.

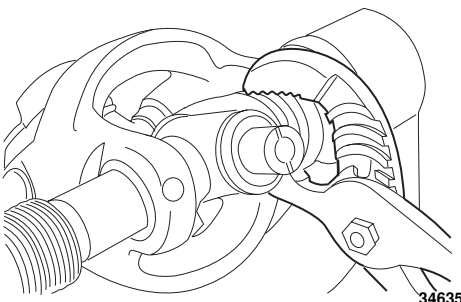
universal joint Installation

Note! Remove all bearing caps from a new Universal Joint. Do not add any grease to the bearing caps. The grease is a permanent lubricant and may be damaged by using incompatible grease.

1. Insert Universal Joint lobes into center coupler of driveshaft.



34636

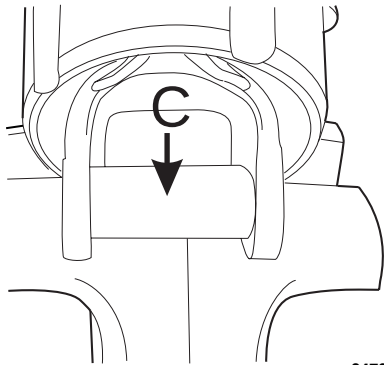


34635

2. Install both bearing caps by hand. Slide Universal Joint back and forth between caps to be sure they're aligned.
3. Press bearing caps on with *Owatonna* Tool, or equivalent. Place open adaptor from Universal Joint Kit, *Volvo Penta* P/N 3850628, in tool and tighten tool until retaining ring groove of one cap completely clears the inside of the coupler.
4. **Wear eye protection.** Discard old retaining rings and replace them with new ones. Attach to cap with pliers or hammer.
5. Remove Universal Joint from tool and rotate it 180°. Press in opposite cap until the retaining ring of the first cap seats against the yoke. Face the open end of the ring toward the driveshaft and attach it to the cap. If necessary, use a punch and hammer to seat the ring in the groove.

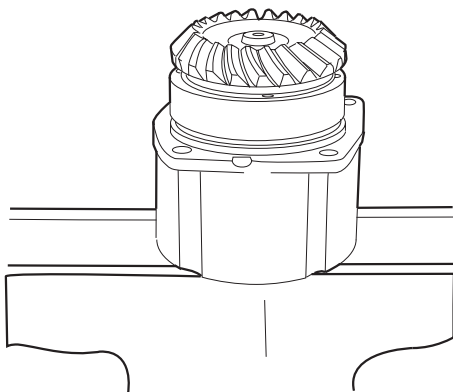
6. Repeat steps 1 thru 5 above for all remaining bearing caps.
7. Check the Universal Joint for freedom of movement. Drive the end caps outward against the clips as necessary to ensure freedom of movement.

Pinion Bearing Carrier Disassembly



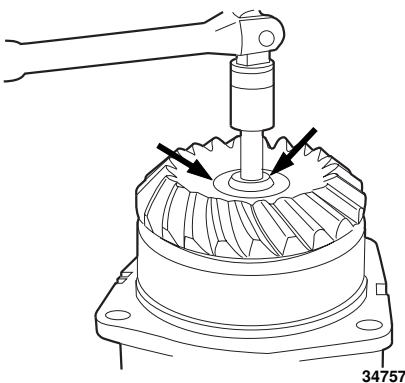
34760

1. Make a Universal Joint Support by cutting a 1 in. (25.4 mm) diameter pipe 2.875 in. (73.0250 mm) long. Slide the support through both yokes.



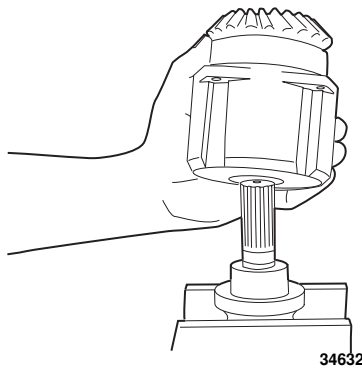
34764

2. Rest the pinion bearing carrier on top of a vise and clamp the yoke securely.

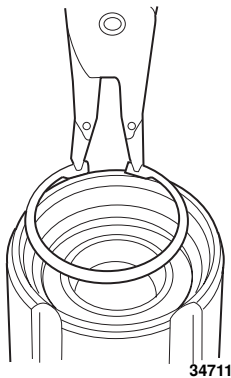


34757

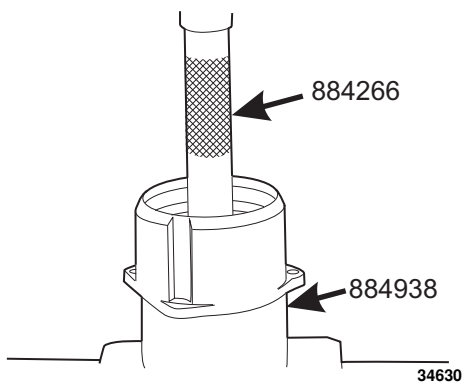
3. Remove the pinion gear retainer screw using a FTX-500 Torx bit. Discard the screw. Remove the pinion gear retainer.



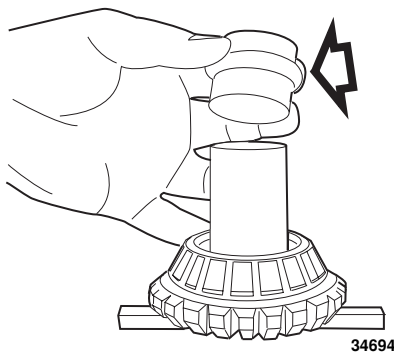
4. Carefully remove the pinion bearing carrier from the Universal Joint shaft. If the pinion bearing carrier is stuck, a press may be used to remove the Universal Joint shaft from the pinion bearing carrier.



5. **Wear eye protection.** Remove the seal C-clip from the pinion bearing carrier by using Retaining Ring Pliers, *Volvo Penta* P/N 3850608-5.

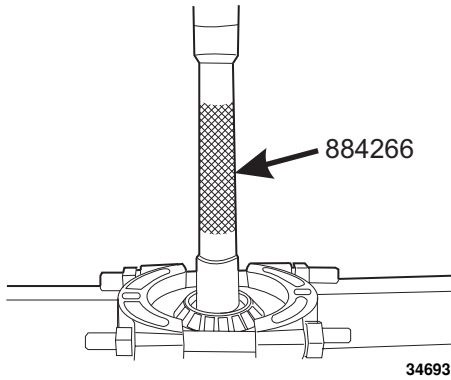


6. Place Sleeve, *Volvo Penta* P/N 884938-2, large diameter up, in a press. Place a rag inside the tool to protect the gear during disassembly. Place pinion bearing carrier into the tool, gear side down. Press out the input gear using Drift, *Volvo Penta* P/N 884266-8.



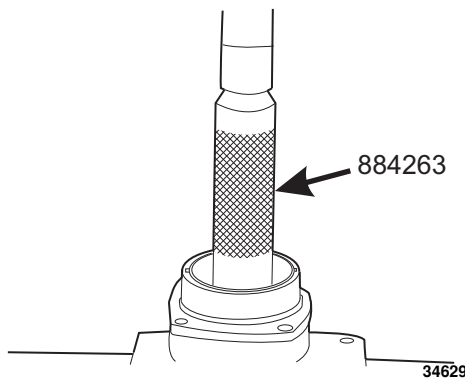
7. Remove the pretension sleeve from the input gear shaft and discard it.

Note! Pretension sleeves must not be reused. Proper rolling torque cannot be achieved with a used pretension sleeve.

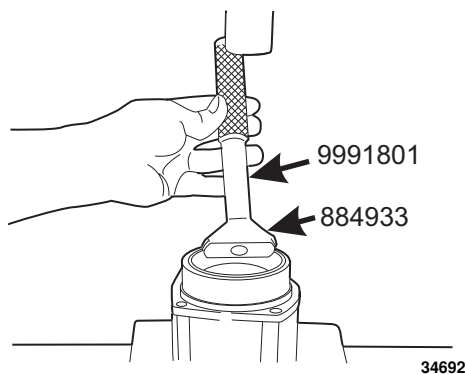


8. Clamp the input gear and bearing in a bearing separator, placing the curved side of the jaws behind the bearing. Remove the gear from the bearing using Drift, *Volvo Penta* P/N 884266.

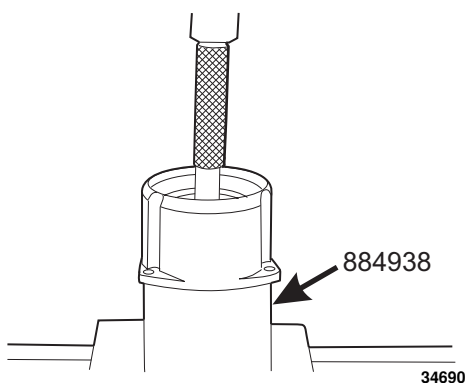
Note! Do not remove the bearing from the input gear unless it is damaged. Removal will destroy the bearing. When replacing any tapered roller bearing, the corresponding bearing race must also be replaced.



9. Place pinion bearing carrier in a press with the seal facing down. Press out the seal and roller bearing using Drift, *Volvo Penta* P/N 884263.



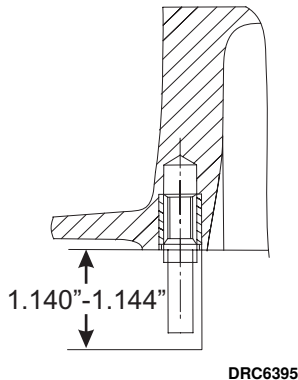
10. Install Disassembly Tool, *Volvo Penta* P/N 884933 on to the end of Shaft, *Volvo Penta* P/N 9991801. Place the pinion bearing carrier in a press large diameter down. Press out the small bearing race.



11. Place Sleeve, *Volvo Penta* P/N 884938 in a press. Turn the pinion bearing carrier over and place it on the tool. Press the large bearing out using the tools in the previous step.

Upper Housing Stud Replacement

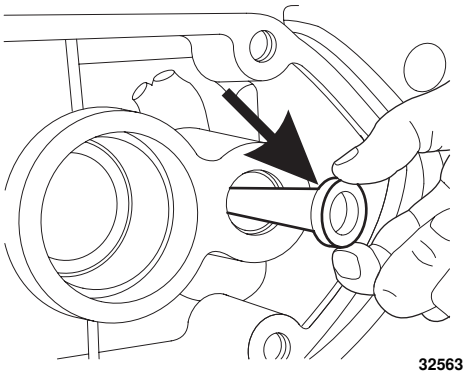
Dual Prop Models Only



DRC6395

1. Remove the stud to be replaced.
2. Apply *Loctite* Primer to the threads on the short end of the stud and let air dry. Apply *Volvo Penta* Thread Locking Compound P/N 1161053 to the threads. Screw the stud into the housing until **1.140-1.144 in. (28,95-29,05 mm)** remains exposed.

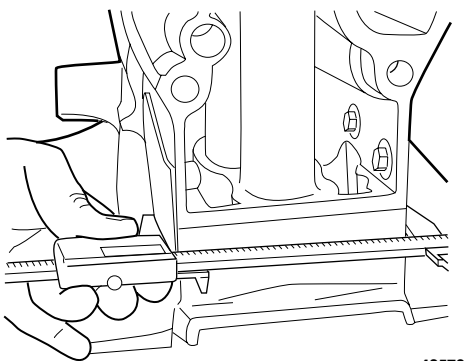
Upper Gear Housing Oil Screen



32563

Remove the oil screen from the upper housing. Clean and replace as necessary. Install the oil screen into the oil passage in the housing. Make sure the screen is secure.

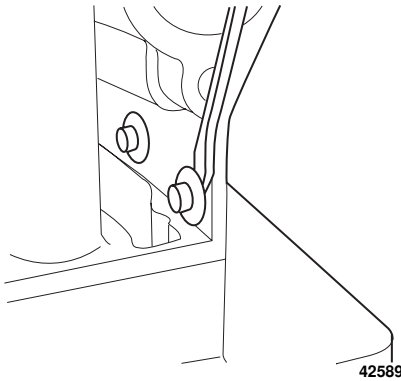
Shimming Thrust Plates



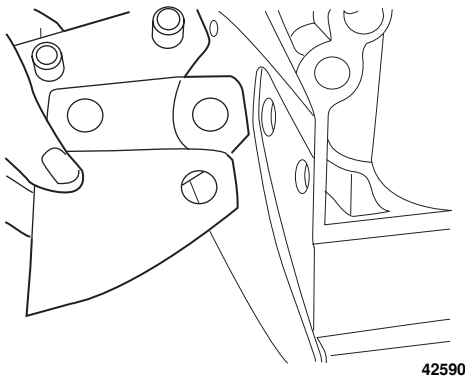
42578

1. Remove the upper gear housing from the holding fixture. Check the width across the thrust plates with a Vernier Caliper. Make sure all space between the shims and the thrust plates are removed. This is a shimmed dimension that should be greater than **5.007 inches (12,72 cm)**, but not exceed **5.036 inches (12,79 cm)**.

Note! Do not remove the thrust plates unless the dimension is incorrect. If the dimension is less than 5.007 inches (12,72 cm), add one shim to each side. If more than 5.036 inches (12,79 cm), subtract one shim from each side.



2. To reset the width, pry off four retaining rings and remove the thrust plates. The retaining rings can be reused unless they are broken. Notice that the concave side of each ring faces inside the housing.



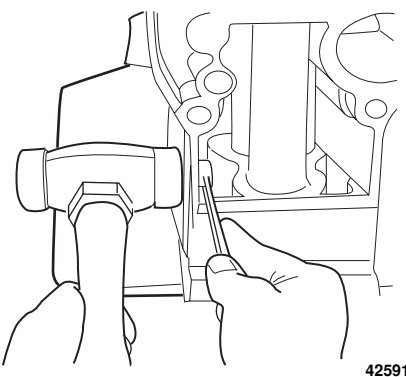
3. Underneath each plate is one or more shims. Each shim is the same size 0.015 in. (0,38 mm). Shims must always be installed in pairs, one on each side of the housing. There must always be a minimum of one shim per side, but no more than four per side. If more than four per side are needed, replace both thrust plates and check the dimension again.
4. To determine if shimming is necessary, compare your measurement with **5.036 (12,79 cm)**.

Example:

5.036 in. required width
- 5.012 in. measured width
0.024 in. difference

In this example, no shims are required. Since shims are added in pairs, the difference would have to exceed 0.030 in. (0.015 in. X. 2) before shims would be needed.

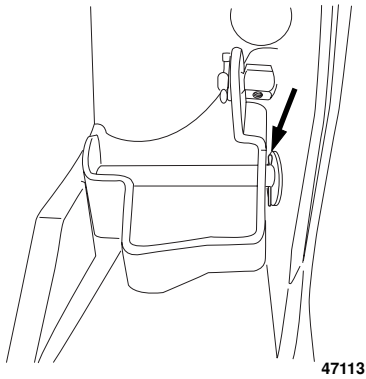
Note! Do not exceed 5.036 in. (12,79 cm) when adding shims. Excessive width will cause interference between the upper gear housing and the transom bracket.



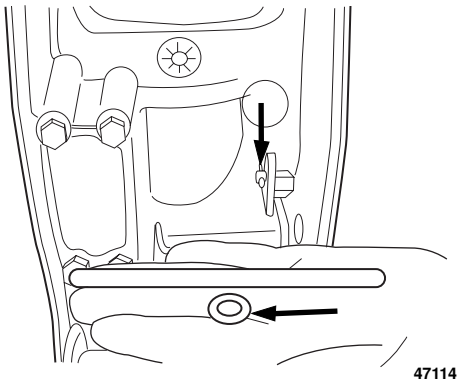
5. Place correct shims on the thrust plates and insert the plates into the housing. Face the concave side of each retaining ring toward the inside of the housing. Push the ring onto the plate stud. Hold the ring with a 1/2 in. box-end wrench. Tap the thrust plate with a soft face hammer until the ring seats against the housing.

Shift Linkage Disassembly

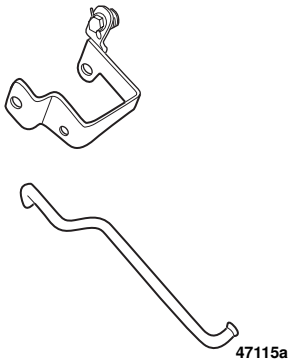
1. Place a flat blade screwdriver in the slotted end of the bellcrank pin. Remove and discard cotter pin.



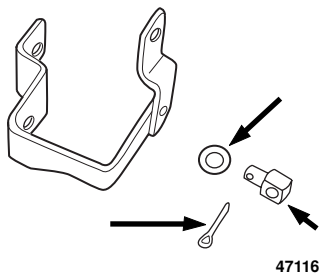
2. Pull out the pin and remove bellcrank assembly and one flat washer.



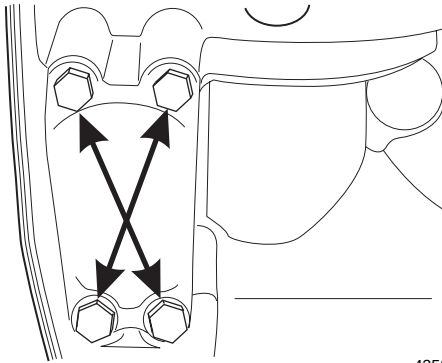
3. Remove shift link from bellcrank.



4. Remove and discard the cotter pin securing the cube to the bellcrank. Remove flat washer then the cube.



Water Passage Plate Service



42580

This plate is a water passage plate and is not removed for normal service. If the unit has a restricted water flow cooling system problem, the plate may be removed to look for debris. A new gasket coated with *Volvo Penta Gasket Sealing Compound* must be used for reassembly. Tighten the four screws to 60-84 in. lb. (6,8-9,5 N.m).

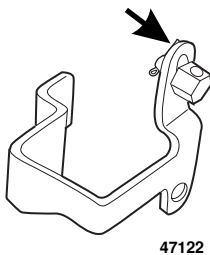
Cleaning and Inspection

Clean the housing in solvent to remove all sealer from screw holes, gasket surfaces, and O-ring bores. Dry the housing thoroughly.

Note! Most threaded holes in the upper gear housing have *Heli-Coil* inserts. Do not use a thread tap to clean screw holes. Tap will damage *Heli-Coil* insert and make replacement necessary. Do not replace with standard non-locking *Heli-Coils*; use only those shown in the appropriate parts catalog.

- **Lock Ring Threads** - lock ring must turn freely for full depth.
- **Cooling Passages** - check for corrosion build-up that would restrict water circulation.
- **Pinion Bearing Carrier Bare** - remove all sharp edges that would cut O-ring.
- **Model I.D. Plate** - transfer plate to new gear housing when replacing old housing.
- **Gears, Shafts and Bearings** - inspect gear teeth for cracks and chips or discoloration. If any gear is damaged all must be replaced. They are replaced as a set. Screw threads on end of shafts must be undamaged. Replace shaft if lock patch is excessively worn. Check for pitting, corrosion and discoloration.
- **Cone Clutch and Shift Shoe** - replace if any signs of excessive wear is found.

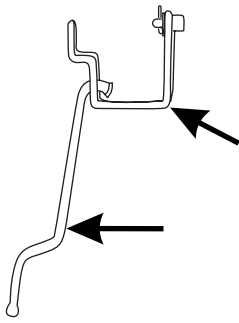
Shift Linkage Assembly



47122

1. Apply *Volvo Penta Grease P/N 828250* to the cube shaft. Install the cube on the bellcrank arm with the slotted hole. Secure with flat washer and cotter pin. Bend the ends of the cotter pin for a secure attachment.

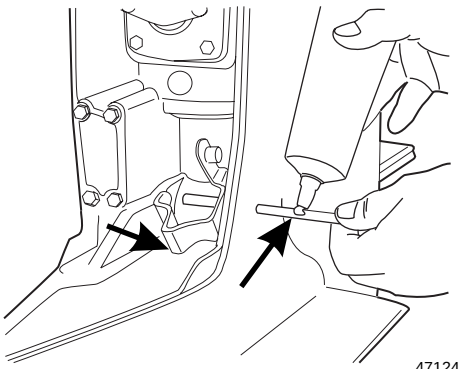
2. Install the shift link into the bellcrank.



47123

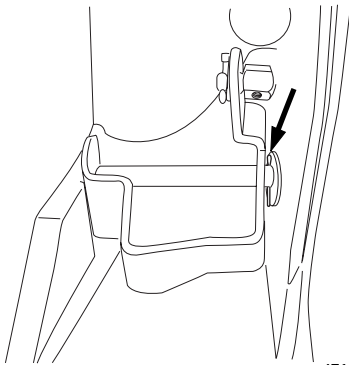
3. Apply *Volvo Penta Grease P/N 828250* to the bellcrank pin. Place the bellcrank assembly inside the housing. Insert the pin into the housing from the starboard side.

Note! The screwdriver slot must face away from the housing.



47124

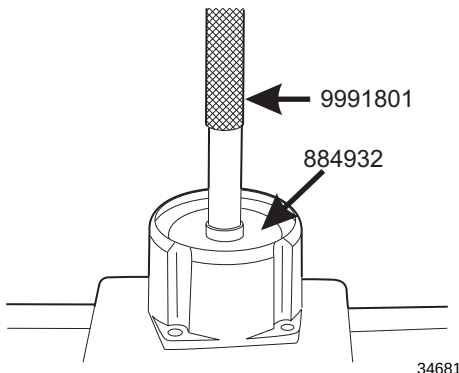
4. Place one flat washer on the pin between the housing and the starboard side of the bellcrank. Push the bellcrank pin all the way through the bellcrank and into the port side of the upper gear housing. Install a cotter pin into the pivot pin between the washer and bellcrank. **Bend the ends of the cotter pin for a secure attachment.**



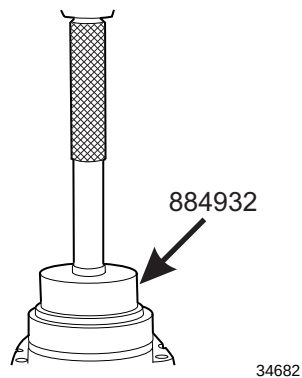
47113

Pinion Bearing Carrier Assembly

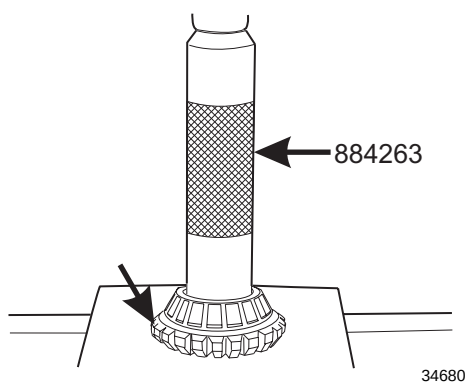
1. Place the pinion bearing carrier in a press with the large opening up. Lightly oil the outside diameter of the small bearing race with *GL5 Synthetic gear lubricant SAE 75W-90* and set it in the carrier. Press the race in until it seats using Assembly Tool, *Volvo Penta P/N 884932-5*, large diameter up, and Shaft, *Volvo Penta P/N 9991801-3*.



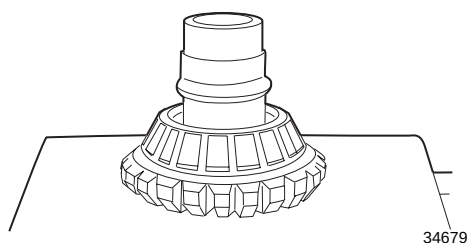
34681



2. Turn the pinion bearing carrier over and set it in the press. Lightly oil the outside of the large bearing race with *GL5 Synthetic gear lubricant SAE 75W-90* and set it in the carrier. Assemble the special tools used in the previous step with the large diameter of Assembly Tool, *Volvo Penta P/N 884932*, facing down. Press the race in until it seats.



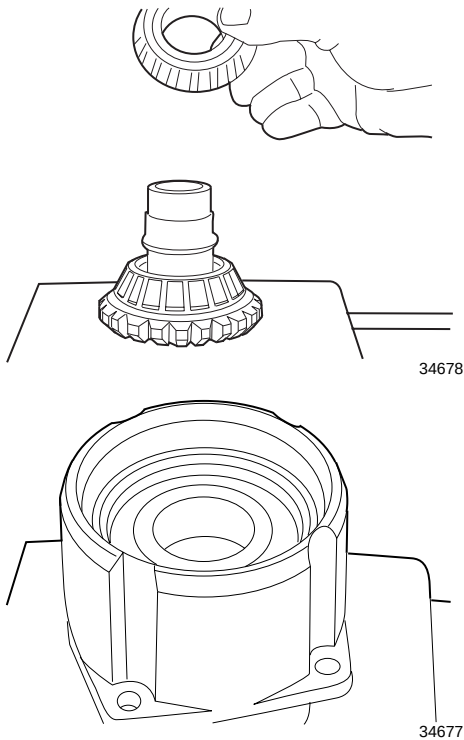
3. Coat the pinion gear shaft with *GL5 Synthetic gear lubricant SAE 75W-90* and set it in the press. Protect the gear teeth. Position the large tapered roller bearing on the input gear and press it until it seats using Drift, *Volvo Penta P/N 884263*.



4. Place a new pretension sleeve on the input shaft.

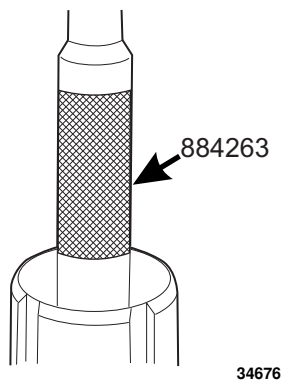
Note! A new pretension sleeve must be used to achieve proper rolling torque.

5. Oil the large and small roller bearings with *GL5 Synthetic gear lubricant SAE 75W-90*. Place the pinion bearing carrier on top of the input gear. Place the small bearing on top of the input bearing shaft.

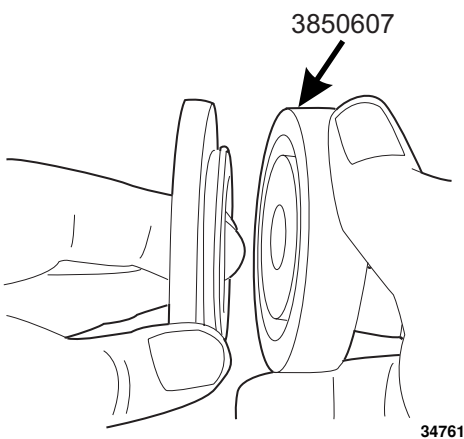


6. Press the small bearing onto the shaft using Drift, *Volvo Penta P/N 884263*, until all end play is removed.

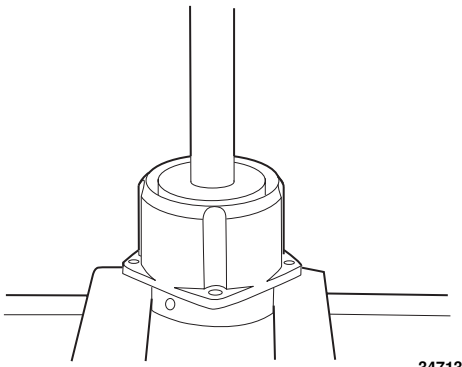
Note! This is the starting point for determining rolling torque of the pinion bearing carrier. Use caution. Do not press the bearing on too far. If the pretension sleeve is distorted by pressing the bearing on too far, proper rolling torque cannot be achieved. The carrier will have to be disassembled and pretension sleeve replaced.



7. Coat the outside surface of a new seal with *Volvo Penta Gasket Sealing Compound*. Place the protruding lip of the seal into the recess of Seal Installer, *Volvo Penta P/N 3850607*.

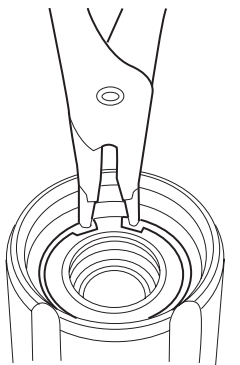


8. Press the seal into the pinion bearing carrier until it seats.



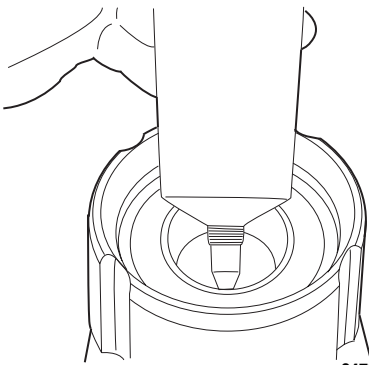
34713

9. **Wear eye protection.** Install seal C-clip into its groove in the pinion bearing carrier using Retaining Ring Pliers, *Volvo Penta* P/N 3850608. Make sure the retaining ring seats completely.



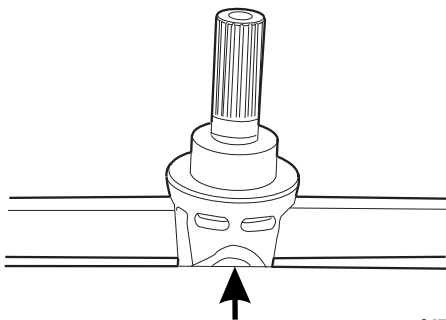
34712

10. Coat the seal lips with *Volvo Penta Grease* P/N 828250.



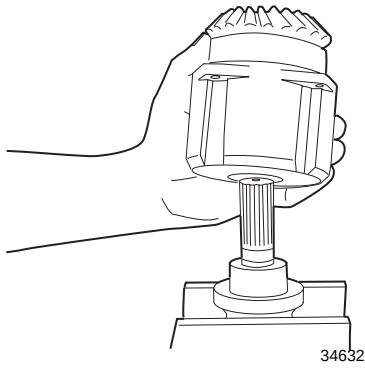
34704

11. Place the Universal Joint yoke support used during disassembly through both yokes and place it in a vise.

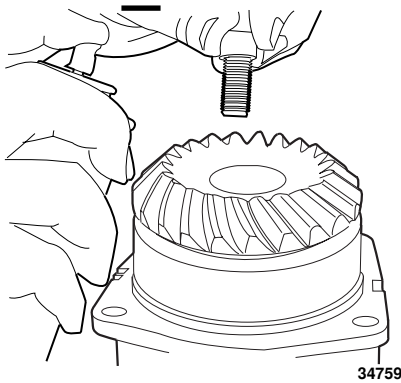


34763

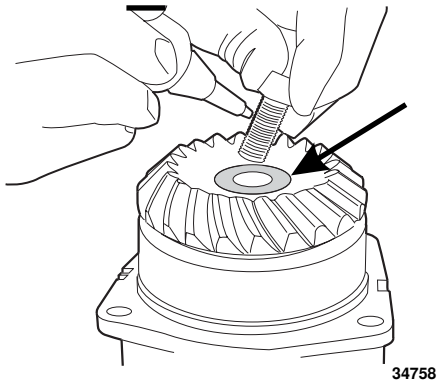
12. Carefully insert the universal joint shaft through the seal and engage the splines of the input gear.



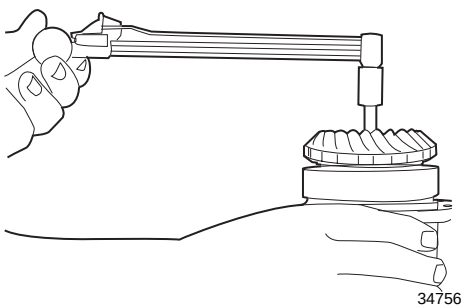
13. Spray the threads of the universal joint shaft and a new pinion gear retainer screw with *Loctite Primer N* and allow to air dry.



14. Place the pinion gear retainer onto the top of the input gear. Apply *Volvo Penta Thread Locking Fluid* P/N 1161053 to the screw threads.

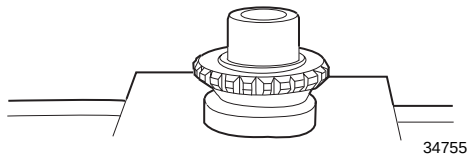
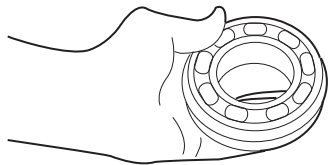


15. Install the screw and tighten a little at a time using *Torx Bit*, P/N FTX500. Turn the pinion bearing carrier while tightening the screw to seat the bearings. Frequently remove the assembly from the vise to check the rolling torque. Stop when the rolling torque reaches **9-14 in. lb. (1,0-1,6 N.m)**.



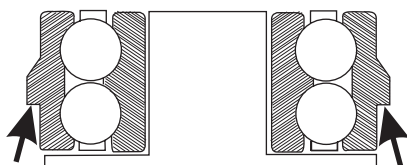
Note! If the rolling torque is exceeded, the pinion bearing carrier will have to be disassembled and a new pretension sleeve installed.

Upper and Lower Output Gears Assembly



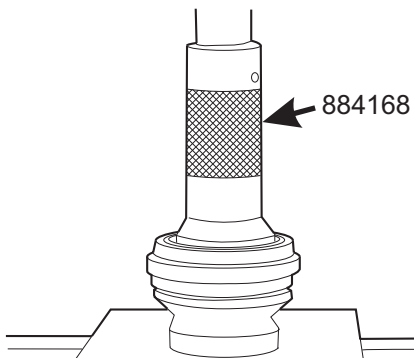
34755

1. Place the lower gear in a press. Protect the gear face. Lightly oil the inside diameter of the bearing with *GL5 Synthetic gear lubricant*.



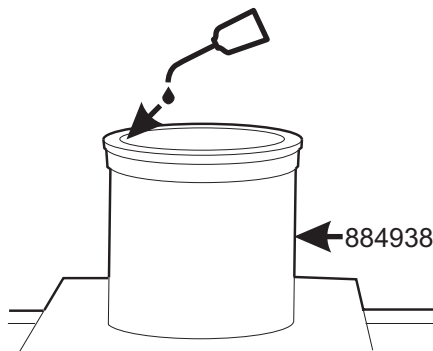
DRC6868

2. Place the bearing, with the square stepped surface facing the gear, on the top of the gear.



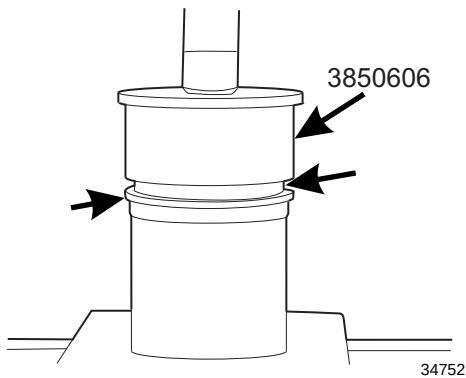
34754

3. Press the bearing in place until it seats, using Drift, *Volvo Penta P/N 884168*.
4. Repeat steps 1, 2, and 3 for upper gear.



34753

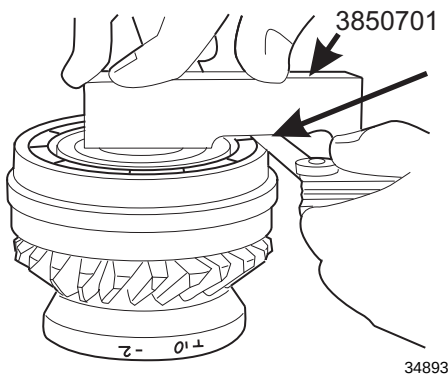
5. Place Sleeve, *Volvo Penta P/N 884938*, large diameter end up, in a press. Lightly oil the inside diameter of the adaptor ring with *GL5 Synthetic gear lubricant*. Place it on top of the sleeve, flange side up.



- Place the upper bearing, gear side down, on top of the adaptor ring. Press the bearing into the adaptor ring until it seats using Remover/Installer, Volvo Penta P/N 3850606, and a suitable piece of flat stock.

Note! The following procedures will set gear position for the input, lower and upper output gears. Record all measurements for future reference.

Lower Output Gear Shimming



- Place the lower gear and bearing assembly, gear side down, on a suitable work surface. Place Shim Tool, Volvo Penta P/N 3850701, on the assembly as shown. Take a feeler gauge measurement at the outer edge of the bearing. Record this measurement.
- Add or subtract the shimming allowance on the gear from the measurement taken in Step 1. This is the amount of shims required to properly position the lower output gear in the upper gear housing.

Note! Because of the location of shims in relation to the gear, use the following information when adding or subtracting the etched allowance figure from the measurement in Step 1.

- If the etched number is +5, you would **SUBTRACT** 0.005 in. from the feeler gauge measurement taken in Step 1.
- If the etched number is -5, you would **ADD** 0.005 in. to the feeler gauge measurement taken in Step 1.
- If the etched number is zero (0), you **ADD or SUBTRACT** nothing to/from the feeler gauge measurement taken in Step 1.

Example: Add / Subtract

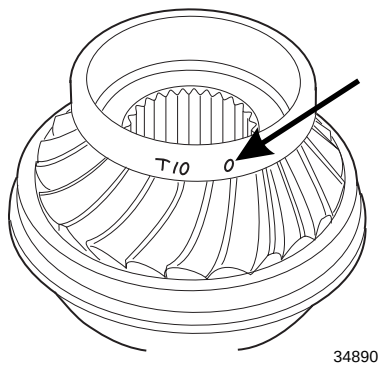
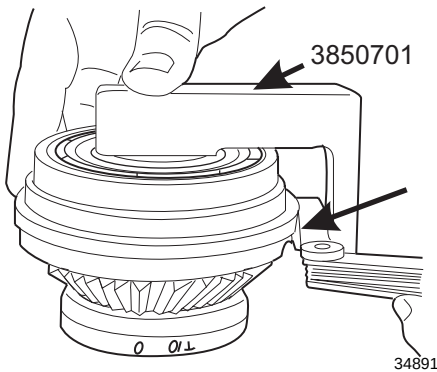
- Feeler Gauge Measurement

$\pm$ - Shimming Allowance Etched On Gear

Amount Of Shims Required

Note! All mating, thrust and bearing faces must be clean. Shims to be used during assembly must be clean and undamaged. No less than one shim but no more than four shims should be used.

Upper Output Gear Shimming



1. Place the upper gear and bearing assembly, gear side down on a suitable work surface. Place Shim Tool, Volvo Penta P/N 3850701, on the assembly as shown. Take a feeler gauge measurement at the lower edge of the adaptor ring. Record this measurement.

2. Add or subtract the shimming allowance on the gear from the measurement taken in Step 1. This is the amount of shims required to properly position the upper output gear in the upper gear housing.

Note! Because of the location of shims in relation to the gear, use the following information when adding or subtracting the etched allowance figure from the measurement in Step 1.

- If the etched number is +5, you would **ADD** 0.005 in. to the feeler gauge measurement taken in Step 1.
- If the etched number is -5, you would **SUBTRACT** 0.005 in. from the feeler gauge measurement in Step 1.
- If the etched number is zero (0), you **ADD or SUBTRACT** nothing to/from the feeler gauge measurement taken in Step 1.

Example: Add / Subtract

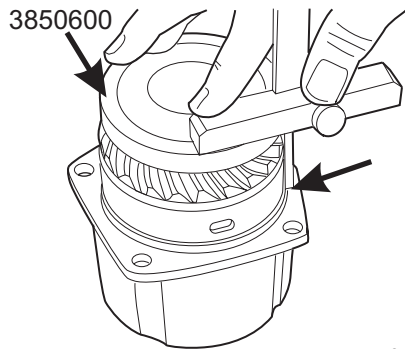
- Feeler Gauge Measurement

$\pm$ - Shimming Allowance Etched On Gear

Amount Of Shims Required

Note! All mating, thrust and bearing faces must be clean. Shims to be used during assembly must be clean and undamaged. No less than one shim but no more than four shims should be used.

Pinion Bearing Carrier Shimming



34978

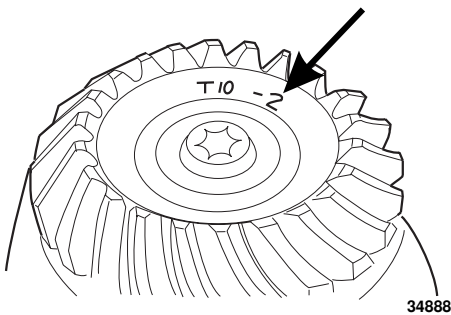
1. Position Shim Fixture Volvo Penta P/N 3850600 on top of the pinion gear, recessed side facing up. Using a vernier caliper or depth micrometer, measure the actual dimension from the top of the tool to the surface of the pinion bearing carrier. Measure in several places, then take an average. Stay away from the bolt holes to get an accurate reading. Subtract 0.500 in. from this measurement.

Example: Subtract

2.489 in. Dimension

- 0.500 in. Thickness of Shim Fixture

1.989 in. Actual Dimension



34888

2. A shimming allowance figure is etched on the pinion (input) gear. Add or subtract the shimming allowance to/from the actual dimension in Step 1.

Note! Because of the location of shims in relation to the gear, use the following information when adding or subtracting the etched allowance figure from the dimension found in Step 1.

- If the etched number is +5, you would **ADD** 0.005 in. to the dimension found in Step 1.
- If the etched number is -5, you would **SUBTRACT** 0.005 in. from the dimension found in Step 1.
- If the etched number is zero (0), you **ADD or SUBTRACT** nothing to/from the dimension found in Step 1.

Example: Add / Subtract

1.989 in. - Dimension found in Step 1

- 0.002 in. - Shimming Allowance Etched On Gear

1.987 in. - Total

3. **1.79:1, 1.97:1, 2.18:1, and 2.32:1 Ratios Only:** Subtract the nominal figure 1.898 from the Total of Step 2. **All Other Ratios:** Subtract the nominal figure 1.971 from Total of Step 2. This figure is the amount of shims required to properly position the pinion gear in the upper gear housing.

Example: Subtract

1.987 in. - Total Of Step 2

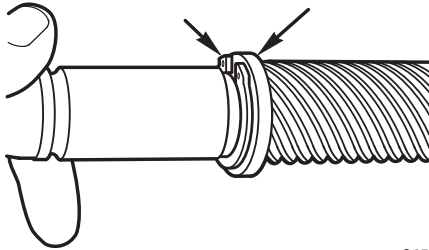
- 1.971 in. - Nominal Figure

0.016 in. - Amount Of Shims Required

Note! Shims are to be placed between the bearing carrier and the upper gear housing. No less than one shim but no more than five shims should be used. Shims to be used must be clean and undamaged.

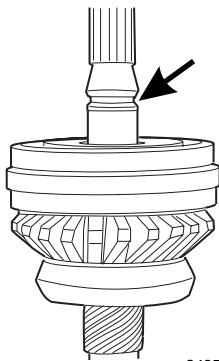
Upper Gear Housing Assembly

Lower Output Gear and Shaft Assembly



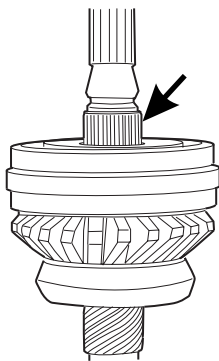
34596

1. **Wear Safety Glasses.** Install the spring spacer onto the splined end of the upper driveshaft with the recessed side facing the helix. Install the spring C-clip on the recess next to the helix.



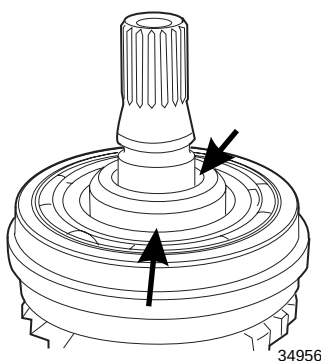
34954

2. Place the upper driveshaft through the lower output gear assembly. The groove must be on the same side as the bearing.



34955

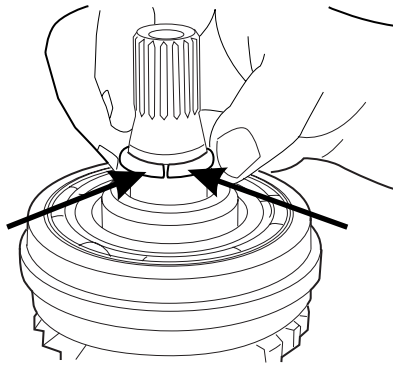
3. Lightly oil the lower needle bearings with *GL5 Synthetic gear lubricant*. Install the needle bearings onto the upper driveshaft with the same top-to-bottom orientation as when disassembled to ensure longevity. New bearings can be installed with either end up. Push the bearing all the way into the gear and bearing assembly.



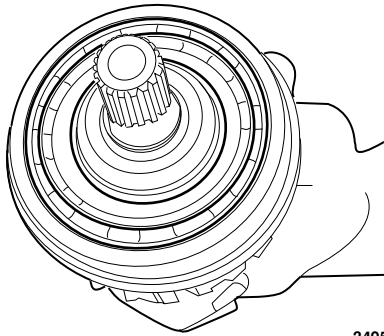
34956

4. Place the ring spacer on to the upper driveshaft with the recess facing up.

5. Place the two upper driveshaft C-clips into the groove on the drive-shaft.



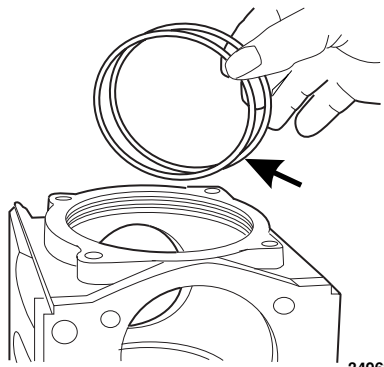
6. Move the driveshaft down to capture the C-clips in the recess of the ring spacer.



34958

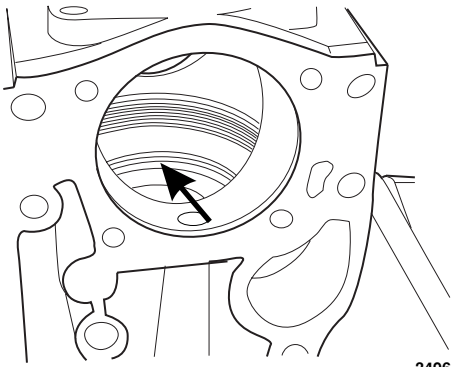
Lower Output Gear Installation

1. Place the required amount of shims determined in a previous step into the upper gear housing.



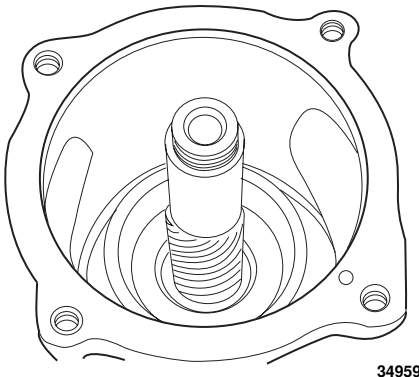
34963

2. Rest the shims on the ledge at the bottom of the bore as shown.



34964

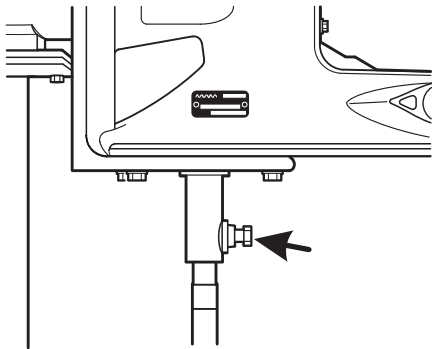
3. Place the lower output gear assembly into the upper gear housing and rest it on the shims. **Do Not** let the driveshaft drop down into the housing.



34959

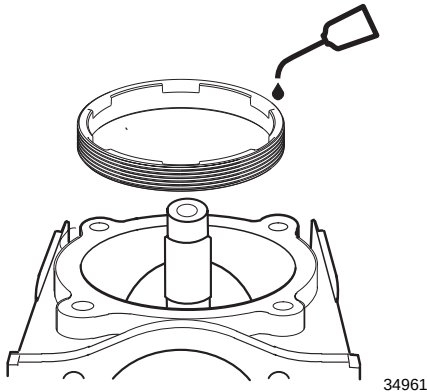
4. Loosen the locking screw and adjust the height of the fixture shaft to engage the upper driveshaft. This will now support the upper driveshaft and retain the C-clips.

Note! Failure to support the driveshaft will allow the C-clips to fall out. Removal of the output gear assembly will be required to reinstall the C-clips.



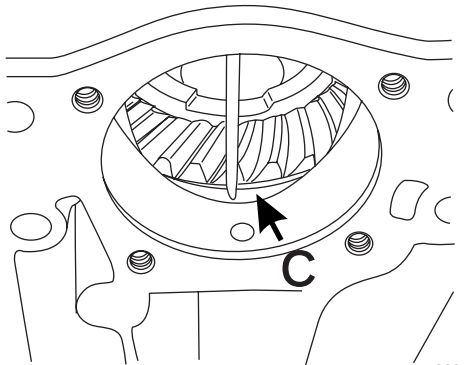
42583

5. Lightly oil the bearing retainer ring with *Volvo Penta GL5 Synthetic gear lubricant SAE 75W-90*.



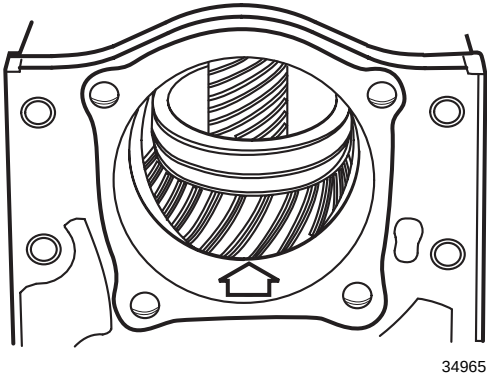
34961

6. Install the ring in the upper gear housing. Thread the ring all the way in by hand until it seats.

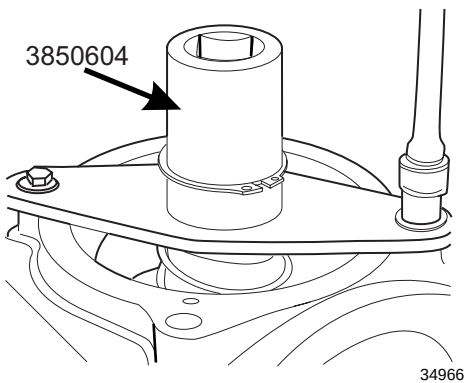


42603

7. When fully seated, the bearing retainer ring will be below the bottom edge of the pinion bearing carrier opening.

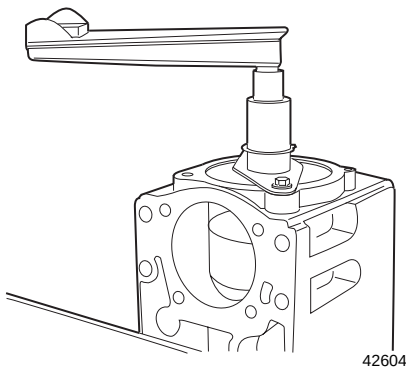


8. Install Spanner Wrench, Volvo Penta P/N 3850604, and secure the tension arm with two upper gear housing top cover screws. Tighten the cover screws down evenly, alternating every two turns. Tighten the screws securely.



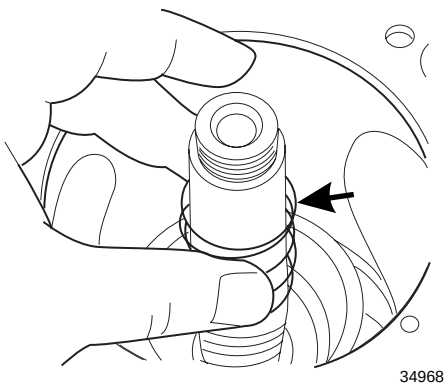
9. Tighten the bearing retainer ring to **145-165 ft. lb. (197-224 N.m)**. Remove the two retaining screws then remove the wrench.

Note! Use caution when removing the retaining screws as the arm is under spring tension.

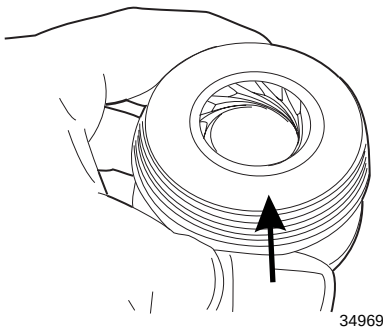


Cone Clutch Installation

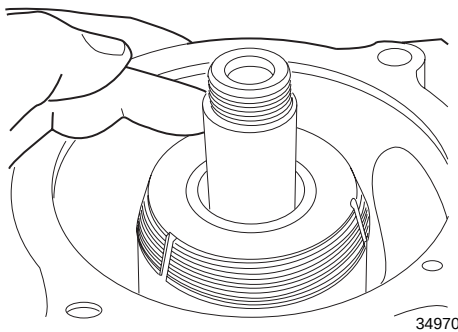
1. Place the cone clutch spring around the upper driveshaft. Slide the spring down into the housing until it rests on the spring spacer.



2. Identify the end of the cone clutch that is marked with the word "TOP".

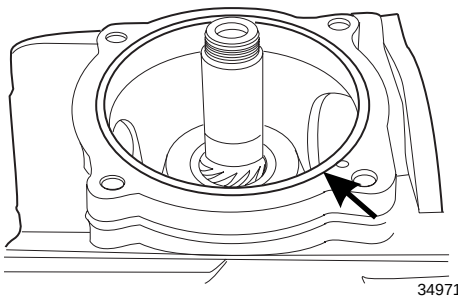


3. Install the cone clutch with the word "TOP" facing **UP**, onto the upper driveshaft. Slowly let the cone clutch spin down the drive-shaft helix until it rests on the spring.



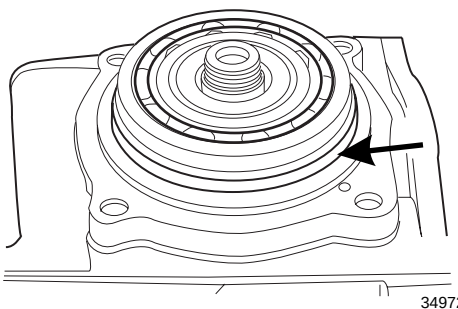
Upper Output Gear Installation

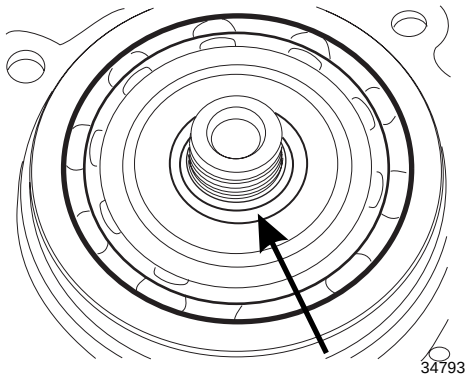
1. Place the predetermined amount of shims to locate the upper output gear into position on top of the upper gear housing.



2. Place the upper output gear on top of the housing and seat the assembly. Be careful not to disturb the shims when installing the bearing assembly.

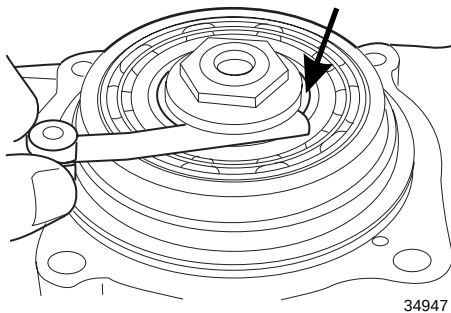
Note! You may have to loosen the four screws that secure the upper housing to the holding fixture, to center the housing and shaft. This will make installation of the upper output bearing assembly easier.



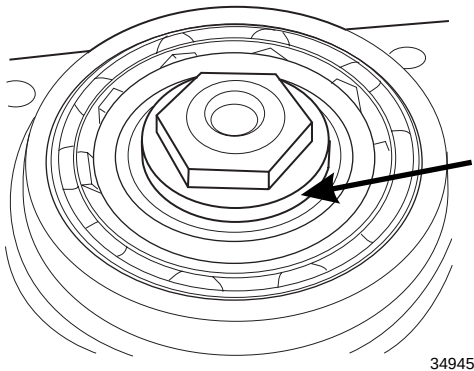


3. Apply *GL5 Synthetic gear lubricant* to the upper needle bearings. Place the bearing on top of the upper driveshaft. Maintain the same top-to-bottom orientation as during disassembly to ensure longevity. New bearings can be installed with either end up. Push the bearing all the way into the gear and bearing assembly.

Shimming Vertical Movement Of Upper Driveshaft



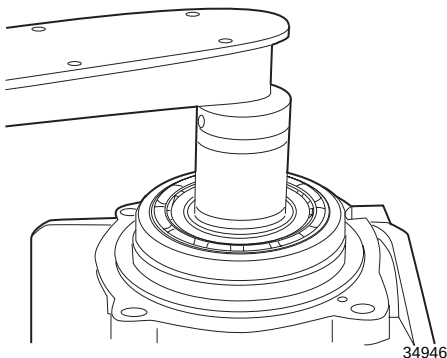
In order to obtain the correct vertical clearance (up and down movement of the upper driveshaft), there are four upper driveshaft nuts with shoulders of different thicknesses.

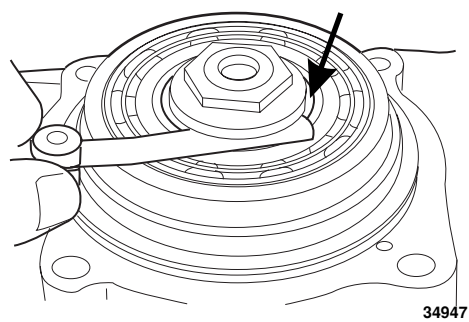


1. Apply *GL5 Synthetic gear lubricant* to the upper driveshaft threads to prevent galling. Select an upper driveshaft nut and install it on the upper driveshaft.

Note! Nut has a *left-hand* thread.

2. Tighten the nut to **96-110 ft. lb. (130-149 N.m)**.





3. Push up on the holding fixture shaft to remove the end play in the upper driveshaft. Measure the clearance between the upper driveshaft nut and the upper output gear bearing. The vertical clearance should be **0.002-0.010 in. (0,05-0,25 mm)**. If the clearance is high, install a thicker nut. If the clearance is low, install a thinner nut. The thickness of the nut can be determined by the number on the top of the nut.

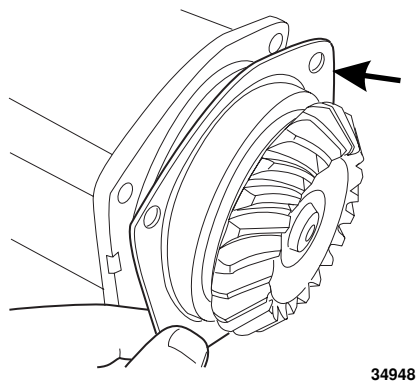
Table 1:

Number	Thickness	Part Number
0	0.000 in.	3852301
2	0.008 in.	3852302
4	0.016 in.	3852303
6	0.024 in.	3852375

4. Retighten the nut to the specified torque and measure the clearance again.

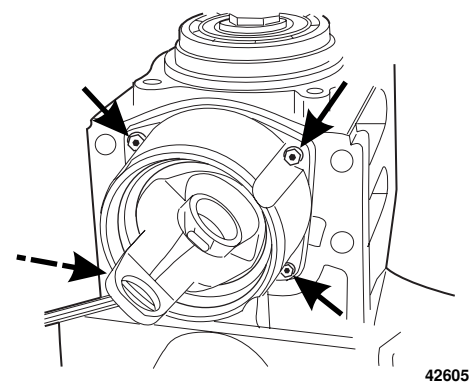
Note! If the proper clearance is not obtainable with any of the nuts, make sure the upper gear, bearing and bearing support ring are correctly assembled. If the components are correctly assembled, the bearing is defective and must be replaced.

Pinion Bearing Carrier Installation



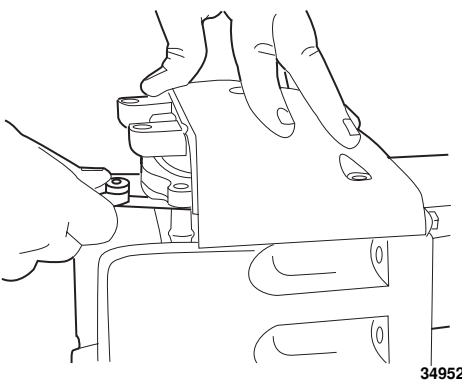
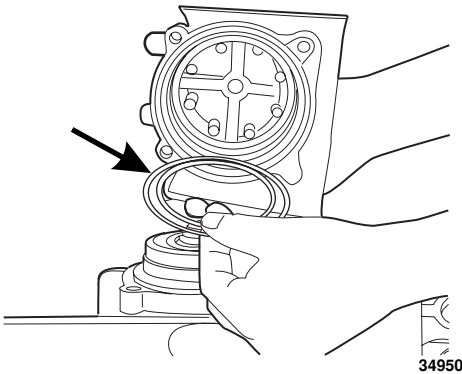
1. Install the predetermined plastic shims that set pinion gear position on the pinion bearing carrier. Do not install an O-ring at this time.

Note! Plastic shims will only fit on the pinion bearing carrier and align with the carrier bolt holes in one direction. Misalignment of the holes will destroy the shims and possibly cause the pinion gear to be out of position.



2. Install the pinion bearing carrier into the upper gear housing and secure with four screws. Tighten the screws to **12-14 ft. lb. (16-19 N.m)**.

Top Cover Shimming



1. Place 0.040 in. of shims (or any other amount) on top of the upper bearing, and record this figure. This will raise the cover enough to make a feeler gauge measurement.

2. Being careful not to displace the shims, install the top cover and push down lightly. Take several feeler gauge readings to determine an average clearance. Record this figure.
3. The specified top cover clearance is **0.002-0.004 in. (0,05-0,10 mm)**. Take the midpoint of this range **0.003 in. (0,075 mm)**, and add it to the initial amount of shims.

Example:

0.040 in. - Initial Amount of Shims (Step 1)

+ 0.003 in. - Midpoint Of Specified Clearance

0.043 in. - Total

4. Subtract the dimension determined in Step 2 from the total of Step 3. The resulting figure will be the shims needed to set top cover clearance to the specified range.

Example:

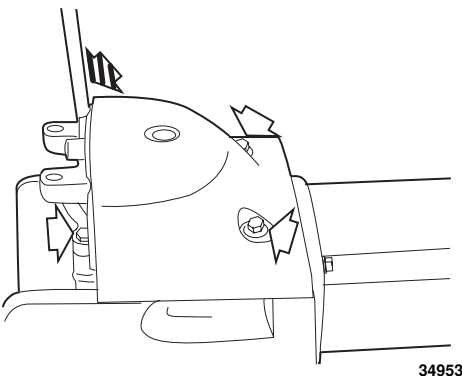
0.043 in. - Total of Step 3

- 0.027 in. - Clearance Measurement (Step 2)

0.016 in. - Amount Of Shims To Be Placed Under Top Cover

Note! Use at least one shim, but no more than four shims.

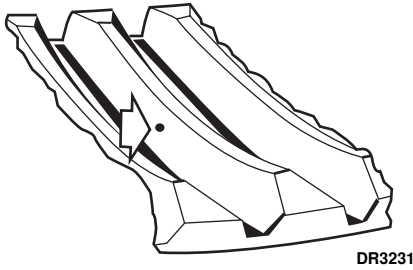
5. Place the correct amount of shims on top of the upper bearing. Being careful not to displace the shims, install the top cover and secure with four screws. Tighten the screws to **16-18 ft. lb. (22-24 N.m)**.



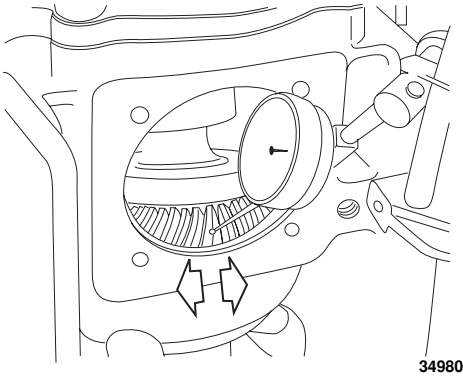
Checking Gear Lash

This procedure will check the relative clearance between the pinion gear and the upper and lower output gears.

Lower Gear

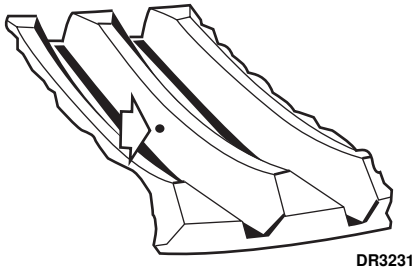


1. Attach a dial indicator to the upper gear housing. Place the indicator tip at the vertical/horizontal midpoint of a lower gear tooth. Proper indicator placement is important for an accurate reading.

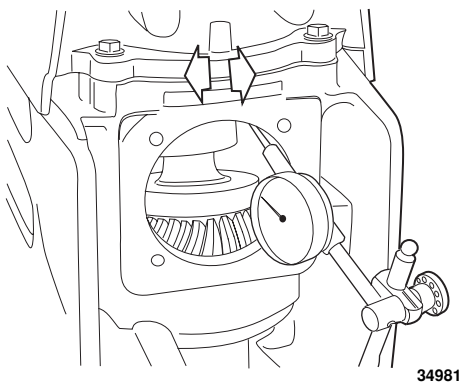


2. Zero the indicator. With your finger, gently rotate the gear first in one direction until tooth contact is felt, then in the other direction. Do not turn the gear far enough to rotate the universal joint, just far enough to contact the pinion gear in both directions. Correct gear lash is **0.006-0.011 in. (0,15-0,28 mm)**. Record your measurements.

Upper Gear

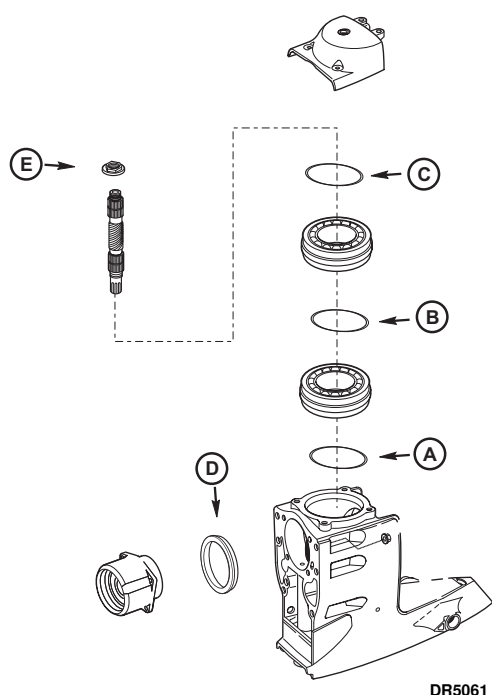


1. Reposition the dial indicator to contact the vertical/horizontal midpoint of an upper gear tooth.



2. Zero the indicator. With your finger, gently rotate the gear first in one direction until tooth contact is felt, then in the other direction. Do not turn the gear far enough to rotate the universal joint, just far enough to contact the pinion gear in both directions. Correct gear lash is **0.006- 0.011 in. (0,15-0,28 mm)**. Record your measurements.

Correcting Gear Lash



If both readings are different, yet within each gear's specified range, gear lash is correct. Gear lash measurements that are incorrect will fall into one of the categories below. Refer to chart and drawing when determining how to change gear lash. Make all shim changes at Position (A) first, then at (B), (C), (D) and (E) in that order.

Determine amount of change by either subtracting range mid-point from reading, or by subtracting reading from range mid-point. A change to shim affects gear lash of both upper and lower output gears.

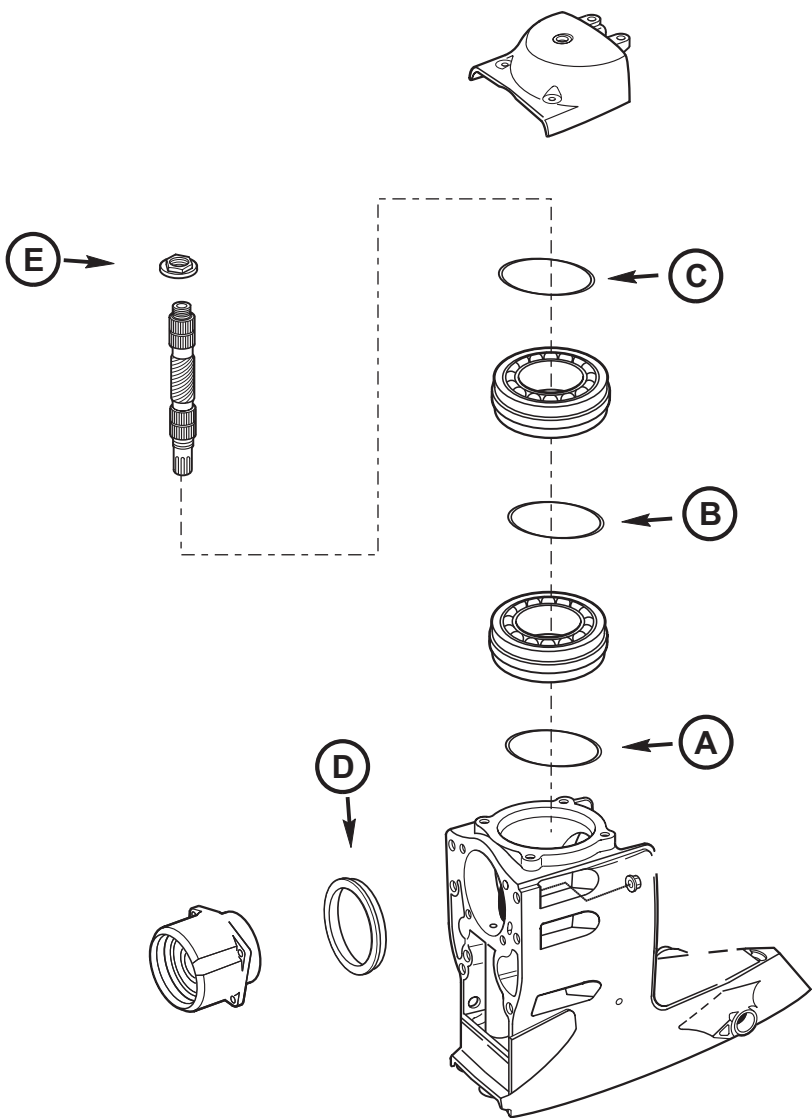
Note! A change to shim affects gear lash of upper output gear only. A change to shim affects gear lash of lower output gear only.

One Gear Correct, One Gear Requires Change

Add or subtract **same amount of shims** at each location indicated.

Table 2:

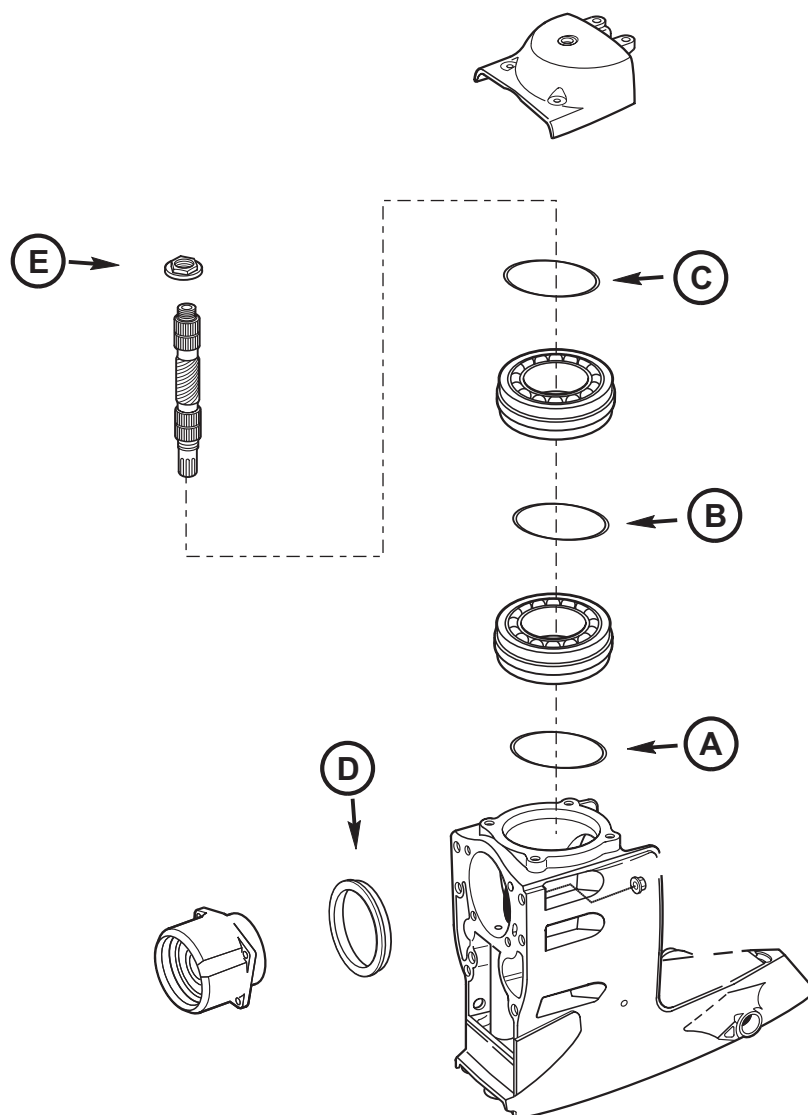
Condition	Positions Requiring Shim Change				
	A	B	C	D	E
Lower gears less than range min. Upper gear within range	Subtract	*	*	*	Re-shim
Lower gear greater than range max. Upper gear within range	Add	*	*	*	Re-shim
Upper gear less than range min. Lower gear within range	*	*	*	*	Re-shim
Upper gear greater than range max. Lower gear within range	*	Add	Re-shim	*	Re-shim
	*	Subtract	Re-shim	*	Re-shim
* No Change Required					



DR5061

Both Gears Incorrect By Same Amount
Add or subtract **same amount of shims** at each location indicated
Table 3:

Condition	Positions Requiring Shim Change				
	A	B	C	D	E
Upper gear greater than range max. Lower gear less than range min.	Subtract	Subtract	Re-shim	*	Re-shim
Lower gear greater than range max. Upper gear less than range min.	Add	Add	Re-shim	*	Re-shim
Lower gear less than range min. Upper gear less than range min.	*	*	*	Add	*
Lower gear greater than range max. Upper gear greater than range max.	*	*	*	Add	*
* No Change Required					



DR5061

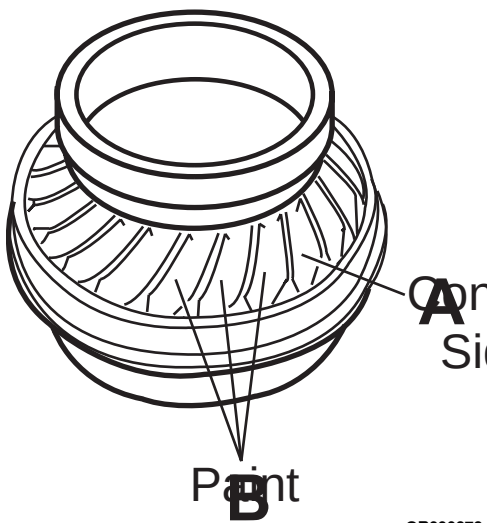
Both Gears Incorrect By Different Amount

Add or subtract **same amount of shims** at each location indicated

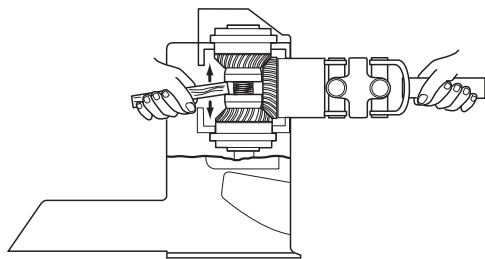
Table 4:

Condition	Positions Requiring Shim Change				
	A	B	C	D	E
Upper gear greater than range max. Lower gear less than range min.	Subtract	Subtract	Re-shim	*	Re-shim
Lower gear greater than range max. Upper gear less than range min.	Add	Add	Re-shim	*	Re-shim
Lower gear less than range min. Upper gear less than range min.	Subtract	Add	Re-shim	*	Re-shim
Lower gear greater than range max. Upper gear greater than range max.	Add	Subtract	Re-shim	*	Re-shim
* No Change Required					

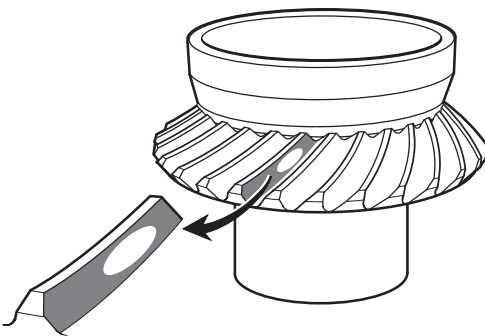
Checking the Gear Teeth Contact Pattern



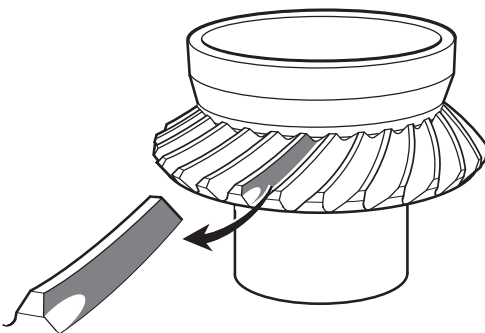
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GR990874



GR990875

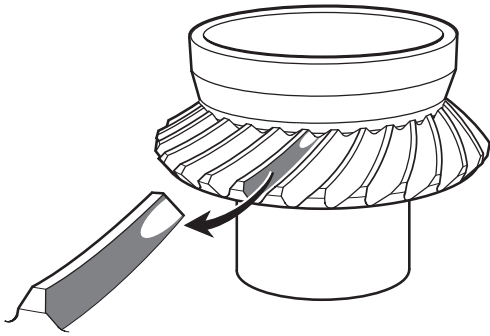
1. In order to achieve long gear life and smooth running with minimum noise, you **MUST** obtain proper gear tooth contact pattern. The contact pattern will give you a visual clue as to where the teeth are meshing with each other. The proper pattern on the upper gear unit will be checked on the driven gears, (upper and lower) on their respective convex sides.
2. Paint three teeth (B) on both the upper and lower driven gears on their convex sides (A) with gear marking compound as shown. You can access the gears through the hole of the shift mechanism. The convex side of the gear teeth should be lightly covered from heel to toe and from crest to root.

Note! The Sliding sleeve should not be installed during this procedure.

3. Insert a piece of wood (approximate size, 1 in. X 2 in. X 6 in.) through the shift mechanism hole between the upper and lower gear cups. Load the gears with the piece of wood while turning the input gear at least six times in the direction of engine rotation (clockwise as viewed from the front of the drive.) This procedure will require the assistance of another person to turn the input gear. Dismantle the gear set and compare the contact pattern to that of the picture.

4. This Picture shows the desired contact pattern for the drive side of the forward and reverse gear. The drive side is the convex side of the gear. The dye pattern should be nearly oval in form and be positioned half way up on the gear tooth. It should be displaced towards the small end of the tooth.

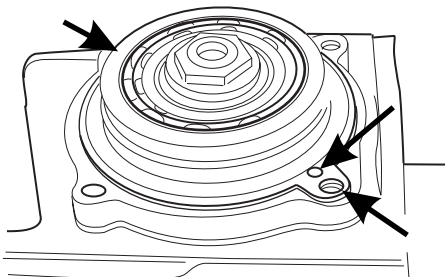
5. If the dye pattern shows contact as shown in figure 4, the shim thickness behind the double bearing box must be reduced (i.e. move the drive gear toward the driven gears.) The driven gears must shimmed outward the same amount to maintain the correct backlash



GR990876

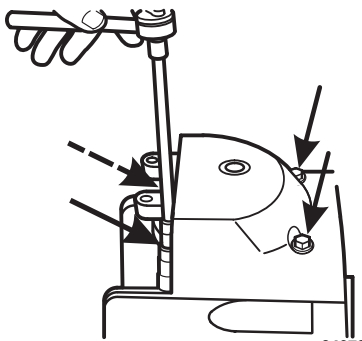
6. If the dye pattern shows contact as shown in figure 5, the shim thickness behind the double bearing box must be increased, (i.e. the drive gear is moved away from the driven gears.) The driven gears must be shimmed inward to maintain the correct backlash.

Final Assembly of Upper Gear Housing



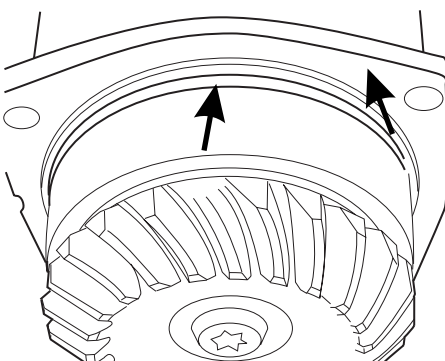
34977

1. Remove the pinion bearing carrier and top cover from the upper gear housing.
2. Coat a surface of a new top cover gasket with *Volvo Penta Gasket Sealing Compound*. Place the gasket around the upper output gear assembly. Orient the tab with the hole in it over the oil circulating passage as shown. Check the position of the shims to make sure they are in position for cover installation.



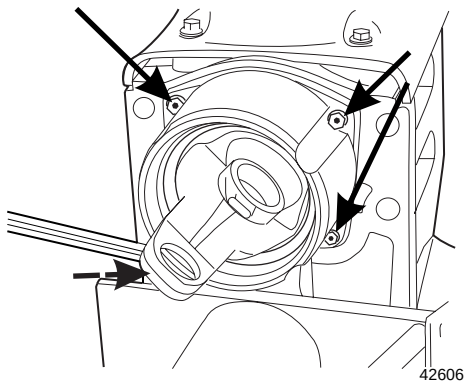
34978

3. Install the top cover and secure with four screws coated with *Volvo Penta Gasket Sealing Compound*. Tighten the screws to **16-18 ft. lb. (22-24 N.m)**.



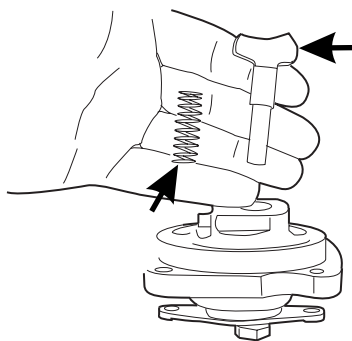
34979

4. Coat a new O-ring with *GL5 Synthetic gear lubricant* and place it in the O-ring groove in the pinion bearing carrier. Check the position of the plastic shims to make sure they are in position for carrier installation.

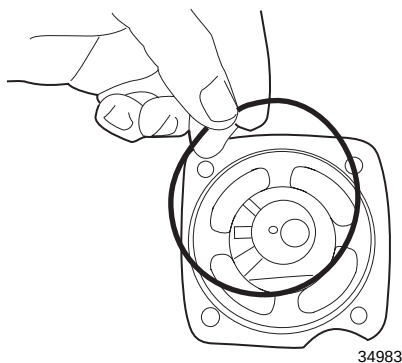


5. Install the pinion bearing carrier and secure with four screws coated with *Volvo Penta Gasket Sealing Compound*. Tighten the screws to **12-14 ft. lb. (16-19 N.m)**.
6. Install universal joints following instructions found elsewhere in this section.

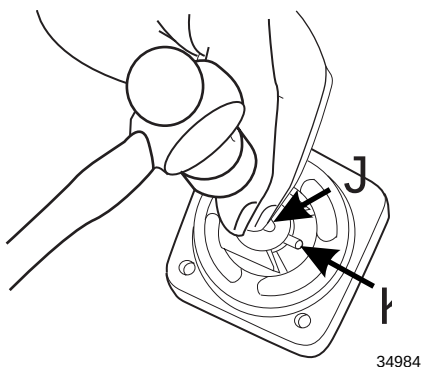
Shift Actuator Housing Disassembly



1. Note the position of the shift shoe for reassembly. Remove shift shoe and spring from the shift actuator housing.

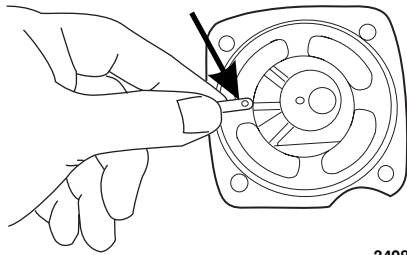


2. Remove and discard the shift actuator housing O-ring.



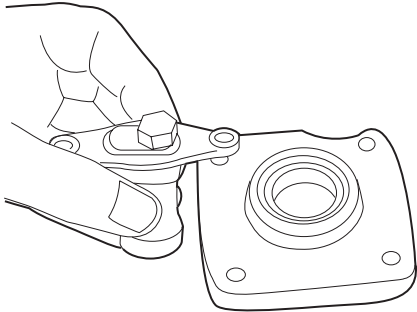
3. Drive the tension pin into the eccentric piston until the eccentric piston pin can be removed.

4. Remove the eccentric piston pin with a pair of pliers.



34985

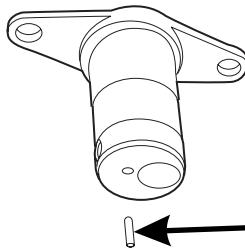
5. Note the eccentric piston's orientation then remove the piston from the housing.



34986

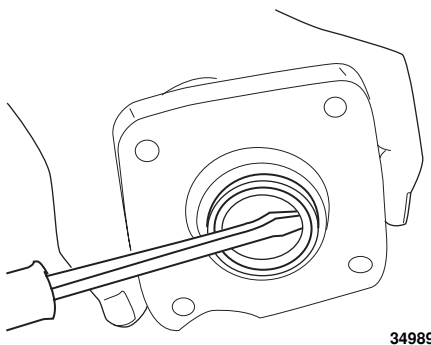
6. Turn the piston over and tap out the tension pin.

Note! The tension pin must be removed before installation. Do not install a new tension pin without removing the old one from the eccentric piston. Having two pins in the hole will make removal of the new one almost impossible.



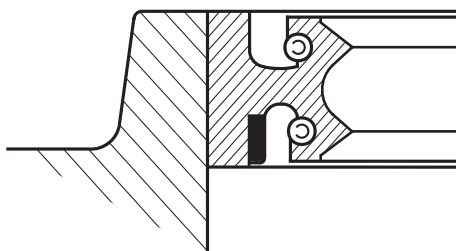
34987

7. Remove the shift actuator seal by inserting a screwdriver behind the seal. Twist the screwdriver and remove the seal. Discard the seal.
8. Clean all parts in solvent and dry with air. Inspect all parts for wear. Replace any defective components.

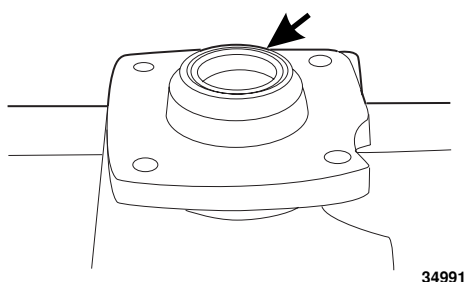


34989

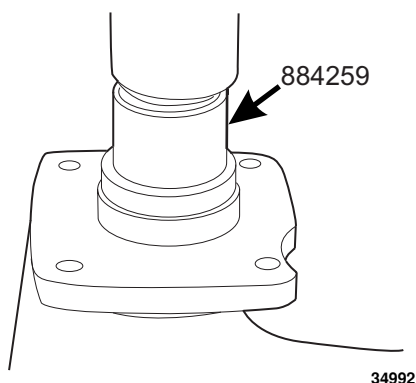
Shift Actuator Housing Assembly



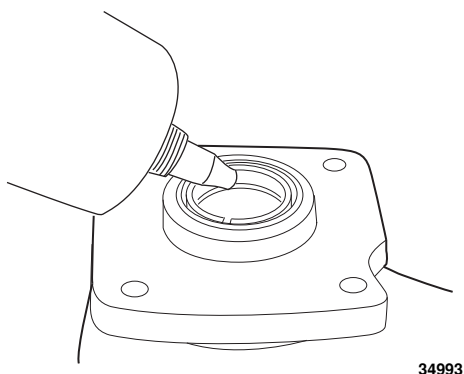
1. Identify the side of the seal that has the larger space between the case and lip. This side must face outwards during installation. Coat the outside case of a new seal with *Volvo Penta Gasket Sealing Compound*.



2. Place the shift actuator housing in a press with the seal cavity facing up. Place the seal in the cavity with the large space facing up.

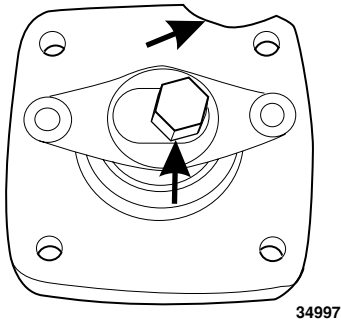


3. Press the seal in place with Drift, *Volvo Penta P/N 884259*, large diameter down, until the tool seats on the housing.

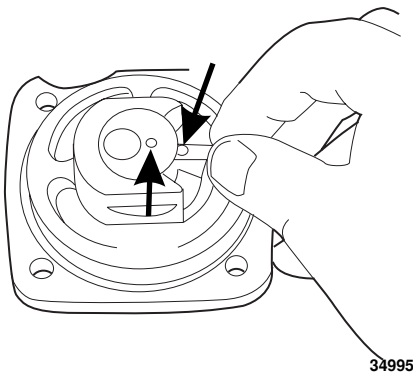


4. Coat the seal lips with *Volvo Penta Grease P/N 828250*.

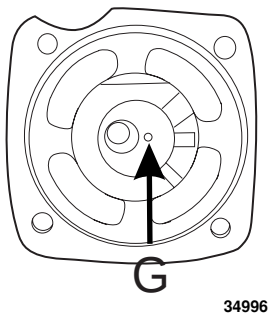
5. Install the eccentric piston through the seal and bushing. Orient the piston with the offset screw towards the side of the housing with the notch.



6. Align hole in the eccentric piston pin with the hole in the eccentric piston. Insert the piston pin into the piston until the two holes align.

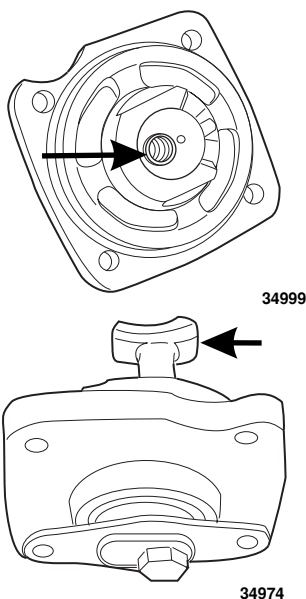


7. Install the tension pin. Drive the pin in until it's flush with the top of the piston.

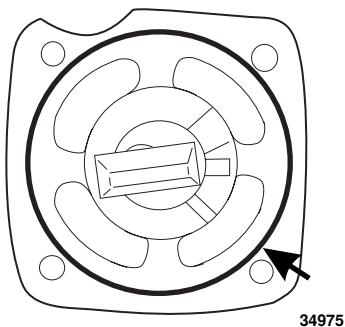


8. Install the shift shoe spring into the hole in the eccentric piston. Install the shift shoe on top of the spring. Orient the shift shoe as shown.

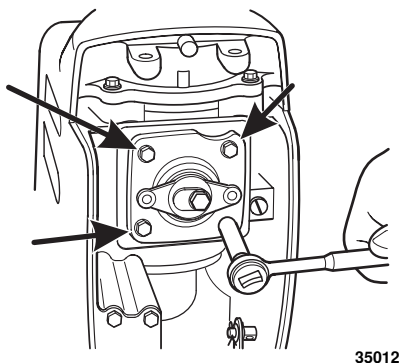
Note! Make sure the shift shoe is installed correctly as shown. The shift mechanism will not operate properly if the shift shoe is installed in any other position.



Shift Actuator Housing Installation

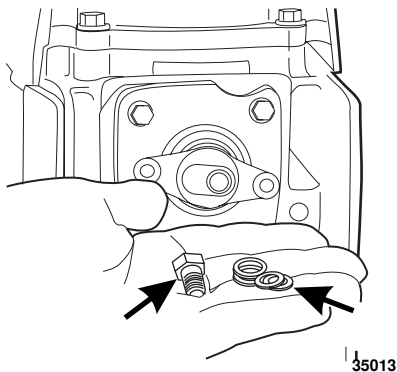


1. Coat a new O-ring with *GL5 Synthetic gear lubricant* and install it in the O-ring groove on the shift housing.

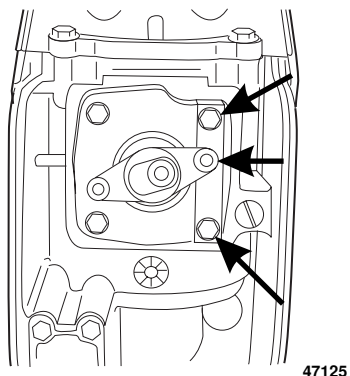


2. Install the shift actuator housing into the upper gear housing and secure with four screws. Tighten the screws to **60-84 in. lb. (6,8-9,5 N.m)**.

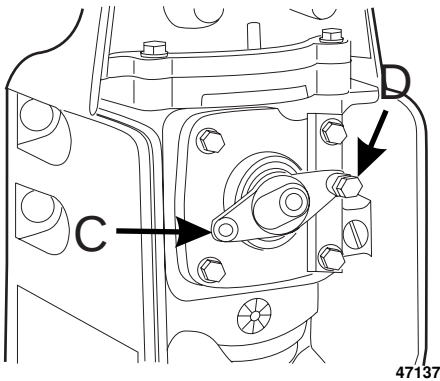
Shimming Shift Actuator Housing



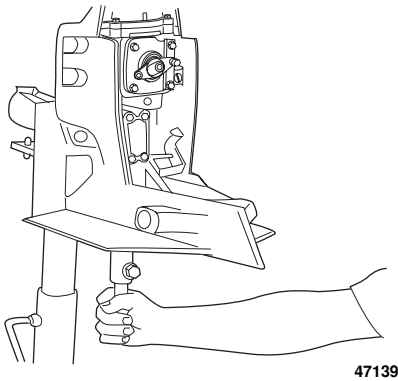
1. Support the eccentric piston arm and remove the shift shoe stop screw and all shims.



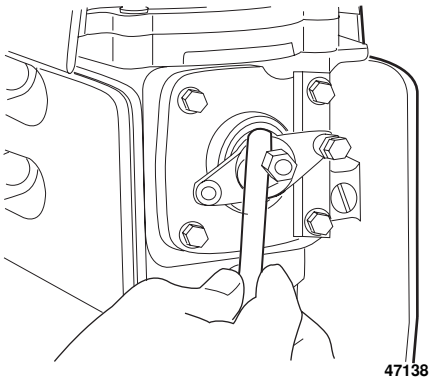
2. Remove the two starboard shift housing screws and set them aside. Install Bracket, and retain with two screws supplied with the bracket. Tighten the screws to **60-84 in. lb. (6,8-9,5 N.m)**.



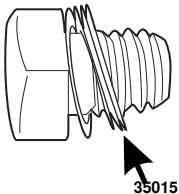
3. Move the eccentric piston arm to locate the hole over the drilled and tapped hole in the bracket. Install the shoulder screw, supplied with the bracket, and tighten securely. This will position the shift system for shimming.



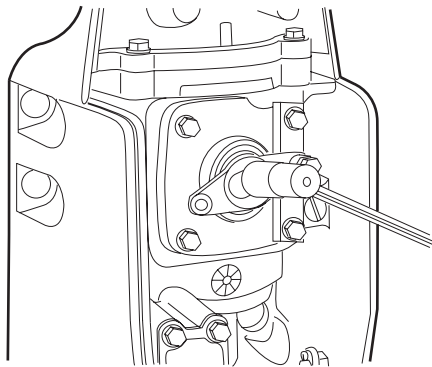
4. Reinstall the shift shoe stop screw, without shims. Tighten the stop screw until it is no longer possible to turn the upper driveshaft. Loosen the stop screw until the upper driveshaft just turns freely.



5. Take a feeler gauge measurement between the housing and the stop screw.

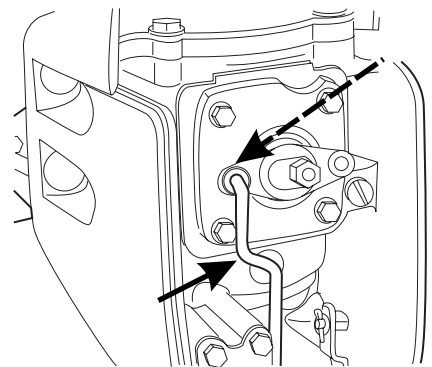


6. Remove the stop screw. Add enough shims to the screw to come as close as possible to the feeler gauge measurement, plus three shims. Shims come in one size only. Coat the screw threads with *Volvo Penta Sealing Compound* P/N 1141570.



47140

7. Install the stop screw with the required amount of shims. Tighten the stop screw to **10-12 ft. lb. (14-16 N.m)**. The upper driveshaft must turn freely. If it doesn't, Re-shim the stop screw.

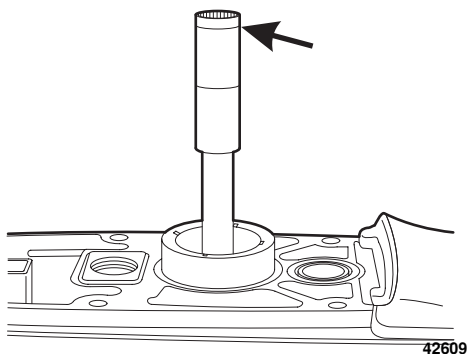


47141

8. Attach the shift link to the eccentric piston arm. Secure with washer and cotter pin. Bend the ends of the cotter pin for a secure attachment.

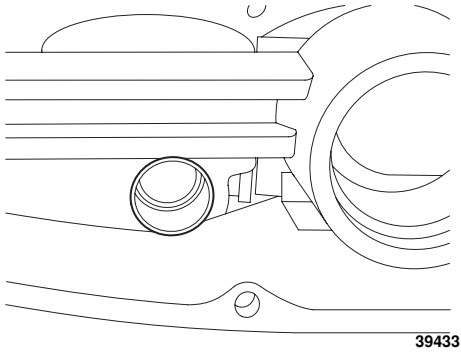
Note! Make sure the bent ends of the cotter pin do not come in contact with the shift housing. Hard shifting and housing damage can occur if the pin ends are not completely bent.

Assembly of Sterndrive



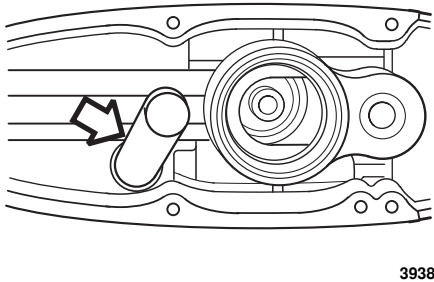
42609

1. Install intermediate driveshaft with the groove facing upward, onto driveshaft.

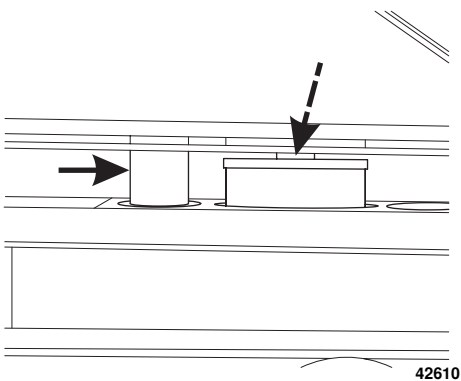


2. Install and position water grommet and supply tube into upper gear housing. Check oil filter for proper installation.

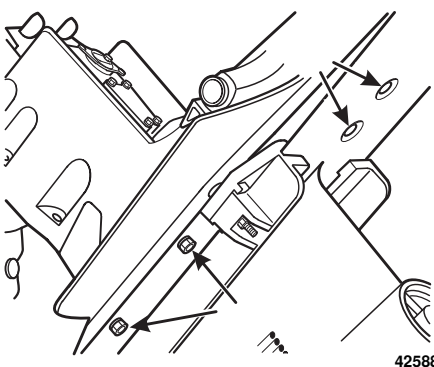
Note! Care must be used on reassembly of gear case. If machined surface is damaged, leakage may occur.



3. Attach upper gear housing to the lower gear case. Engage intermediate driveshaft splines and water supply tube.



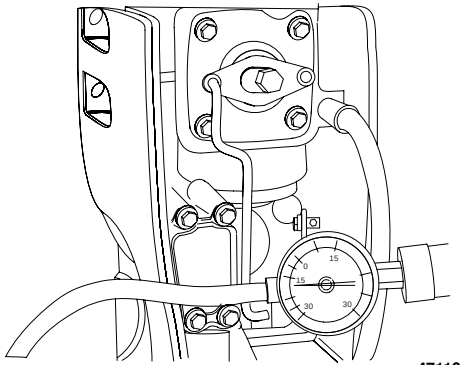
4. Apply *Volvo Penta Gasket Sealing Compound* to the lower gear case mounting screws. Install four short screws, two on either side of gear case, and two longer screws aft. Tighten **3/8-16** screws to **22-24 ft. lb. (30-33 N.m)** and **7/16-14** screws to **32-40 ft. lb. (43-54 N.m)**.



Pressure and Vacuum Testing Stern-drive

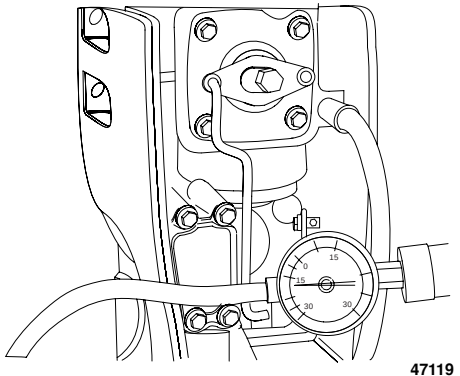
Before filling drive with gear case oil, it must be pressure and vacuum tested to verify proper sealing during assembly. Install magnetic drain plug on side of gear case skeg and oil level gauge at top of drive. Remove the oil level plug at the back of the gearcase.

Pressure Testing



1. Attach a pressure tester (such as a Stevens S-34) to oil level hole, and pressurize drive to **3-5 PSI (20,7-34,5 kPa)**. Rotate propeller shaft and universal joint shaft to check sealing. If pressure loss is indicated, use a soapy water solution or submerge drive in water to find source. Make necessary repairs then repeat test.
2. If pressure loss is not indicated, increase pressure to **16-18 PSI (110-124 kPa)**. Again, use a soapy water solution or submerge in water to find source if drive loses pressure. Make repairs as necessary and repeat test. Drive must hold pressure before making vacuum test, and must not lose more than **1 PSI (6,9 kPa) in 3 minutes**.

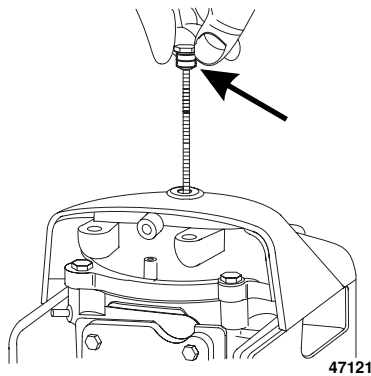
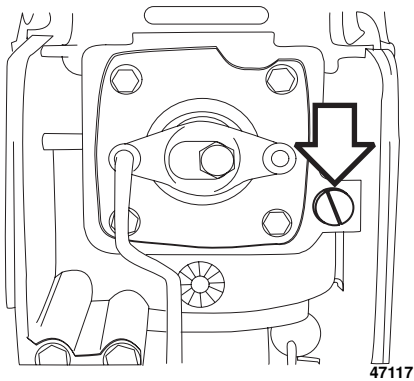
Vacuum Testing



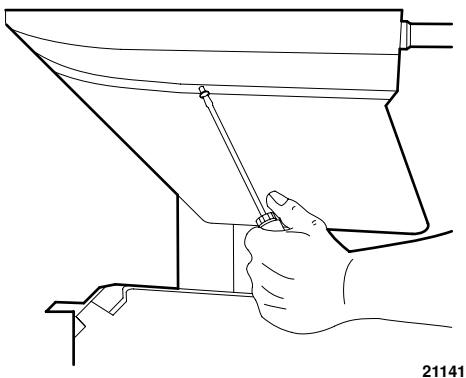
1. Attach a vacuum tester (such as a Stevens V-34) to oil level hole, and pull vacuum to **3-5 inches of mercury (10-16,8 kPa)**. Rotate propeller and universal joint shaft to check sealing. If drive does not hold vacuum, apply a heavy oil to seal and gasket surfaces to find source. Make necessary repairs then repeat test. No loss of vacuum should occur on low test.
2. If vacuum loss is not indicated, increase vacuum to **14-16 inches of mercury (47-54 kPa)**. Again, apply heavy oil to find source if drive will not hold vacuum. Make repairs as necessary and repeat test. Drive must not lose more than **1 inch of mercury (3,4 kPa) in 3 minutes**.

Sterndrive Filling

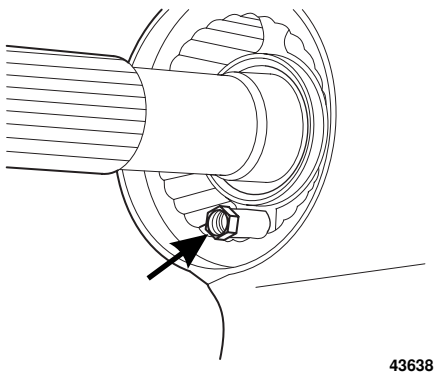
Do not fill sterndrive with oil until it passes both pressure and vacuum tests. Drives that fail either test will allow water entry when in use and cause subsequent damage to internal parts.



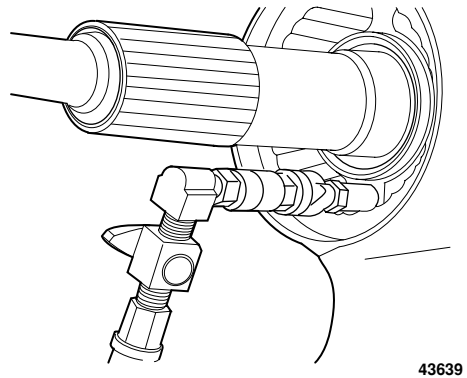
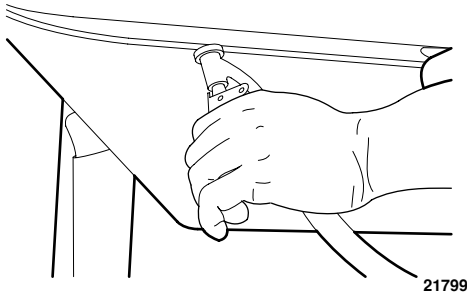
1. Place drive in a vertical position. Remove the rear plastic cover to allow access to the oil level plug. Remove the oil level plug. Also remove the level indicator gauge at top of drive to help vent the oil reservoir. Discard the plug and gauge seal. Replace them with new ones.



2. **SX Models Only:** Remove magnetic drain screw on side of skag. Discard screw seal and replace with a new one.

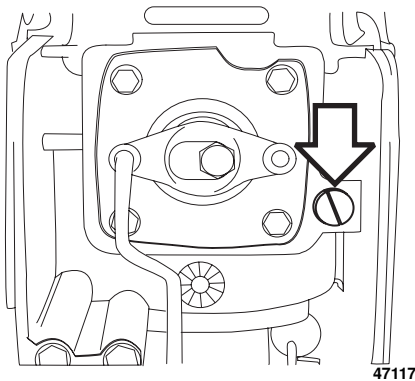


3. **DP-S Models Only:** Remove drain screw at the back of the gear-case. Discard screw O-ring and replace with a new one. Install Fill Adaptor, Volvo Penta P/N **3855932**.

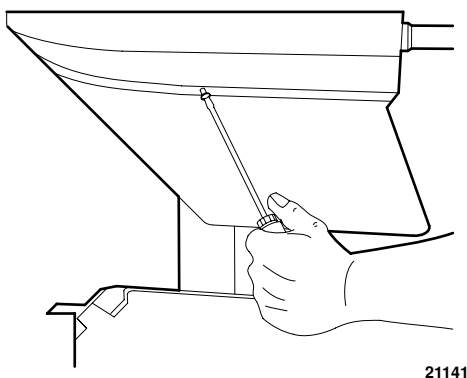


4. Fill drive with *GL5 Synthetic gear lubricant* from drain hole. Fill slowly to purge trapped air. Stop filling when the oil level reaches the bottom of the oil level hole. **Do not overfill.**

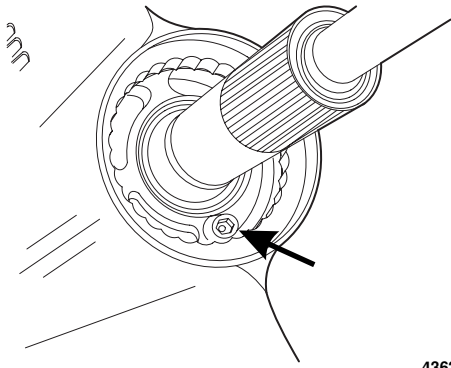
Note! Filling drive too quickly may form air pockets that will cause an inaccurate oil level reading. Running drive with improper oil level can result in immediate internal damage.



5. **All Models:** When oil reaches proper level, stop filling and screw in the level plug and gauge. This will create an air lock to prevent excessive oil loss while drain plug is installed.

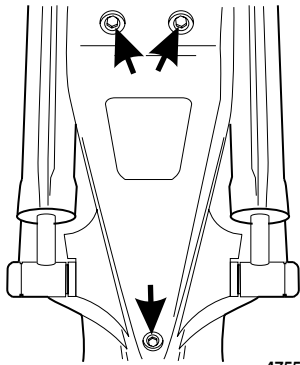


6. **SX Models Only:** Apply *Volvo Penta Gasket Sealing Compound* to the drain plug, and tighten to 60-84 in. lb. (6,8-9,5 N.m). Apply *Volvo Penta Gasket Sealing Compound* to the level plug and gauge. Tighten them to **48-72 in. lb. (5,4-8,1 N.m)**.



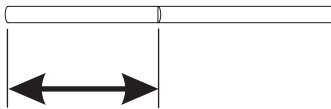
43635

7. **DP-S Models Only:** Apply *GL5 Synthetic gear lubricant* to the drain plug O-ring. Install and tighten drain plug to **10-15 ft. lb. (14-20 N.m)**.
8. Install the sterndrive and adjust the shift system following the instructions under **Sterndrive Removal and Installation**.



47557

9. If the sterndrive is not to be installed, install the shift linkage access cover and secure with three screws. Tighten the screws to **108-132 in. lb. (12-15 N.m)**.



33836

10. After drive has been run, recheck oil level. Add make-up oil through gauge opening to bring oil up to the proper level somewhere in the range on the dipstick.

Specifications

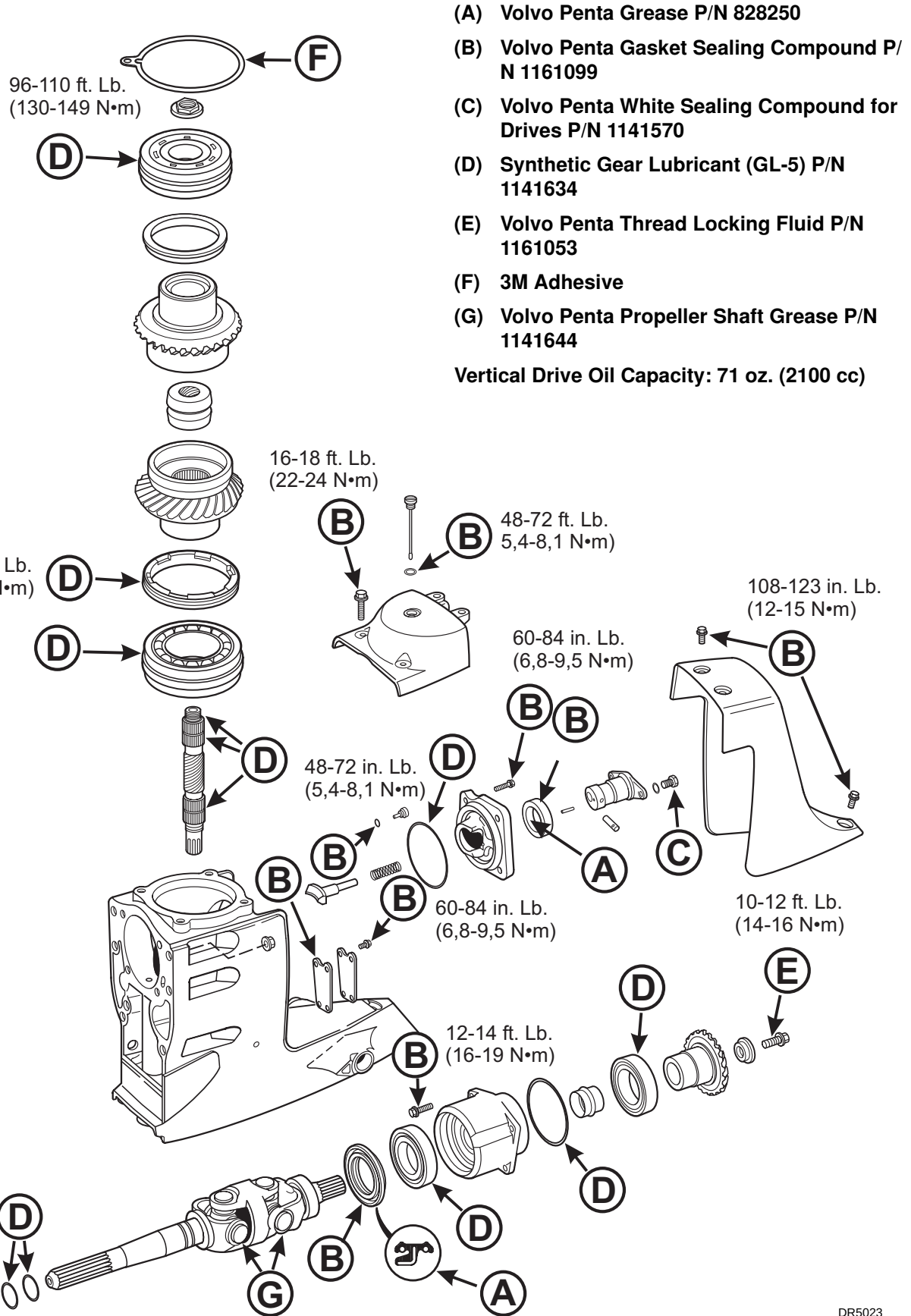
Description	U.S.	Metric
Bearing retainer ring	145-165 ft. lb.	197-224 N•m
Nut		
Upper driveshaft	96-110 ft. lb.	130-149 N•m
Screw		
Drain - Single Proper	60-84 in. lb.	6,8-9,5 N•m
Drain - Dual Prop	10-15 ft. lb.	14-20 N•m
Lower to upper gear housing		
3/8-16	22-24 ft. lb.	30-33 N•m
7/16-14	32-40 ft. lb.	43-54 N•m
Oil level gauge and plug	48-72 in. lb.	5,4-8,1 N•m
Pinion bearing carrier	12-14 ft. lb.	16-19 N•m
Shift actuator housing	60-84 in. lb.	6,8-9,5 N•m
Shift linkage access cover	108-132 in. lb.	12-15 N•m
Shift shoe stop screw	10-12 ft. lb.	14-16 N•m
Top cover	16-18 ft. lb.	22-24 N•m
Water passage cover	60-84 in. lb.	6,8-9,5 N•m

Sealants, Lubricants and Adhesives

Table 5:

Primer	Where Used
Loctite Primer	Pinion gear retainer screw
Adhesive	
Volvo Penta Thread locking compound P/N 1161053	Pinion gear retainer screw
Lubricants	
<i>Volvo Penta Propeller Shaft Grease</i> P/N1141644	universal joints
Volvo Penta Grease P/N 828250	Seal lips Shift linkage pivot points
DPL Penetrating Lubricant	O.D. of rubber coated seals
GL-5 Synthetic gear lubricant	Threads, upper driveshaft O-ring, pinion bearing carrier O-ring, shift actuator housing
Sealants	
Volvo Penta Gasket Sealing Compound P/N 1161099	Gauge and plug, gear case oil level Screws, water passage plate Screws, pinion bearing housing Screw, drain Screws, lower to upper gear case Screws, shift actuator housing Screws, shift linkage access cover Screws, top cover
Volvo Penta White Sealing Compound for Drives P/N 1141570	Shift shoe stop screw
Adhesives	
3M Adhesive	Gasket, top cover

Service Chart



DR5023

SX Lower Gearcase

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Safety Warnings Before beginning work in this section, read Safety chapter at end of this manual.

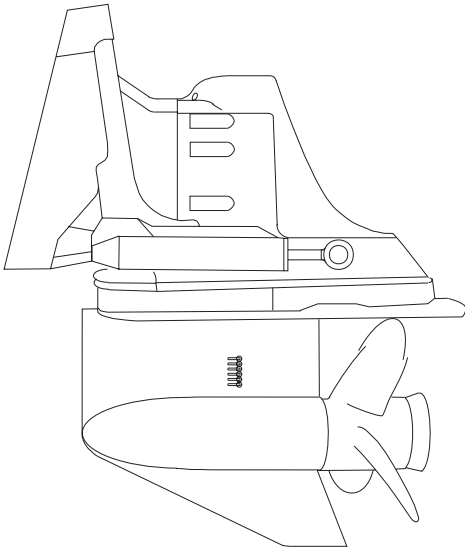
Several of the following procedures require the use of an arbor or hydraulic press. Always wear safety glasses when using this device to perform these procedures.

Special Tools
Table 1:

Tool Name	Volvo P/N	Panel Location
Alignment Plate	3850613-5	F
Bearing Cup Installer	3850616-8	F
Bearing Cup Installer	3850621-8	G
Bearing Installer	-	F
Bearing Remover	3850625-9	G
Drive Handle	3850609-3	A
Drive Handle - Short	3850610-1	A
Driveshaft Holding Socket	3850618-4	G
Gear Lash Extension	3850602-8	H
Guide Plate	3850619-2	G
Housing Remover/Installer	3850707-5	F
Pinion Bearing Installer	3850620-0	G
Pinion Nut Holder	3854864-0	H
Pinion Shim Fixture	3855098-8	H
Propshaft Bearing Installer	3850617-6	G
Puller Bridge	3850611-9	A
Puller Jaws	3850612-7	A
Pusher/Puller	3850623-4	G
Remover/Installer	3850624-2	G
Remover Tip	3855859-9	M
Retainer Installation Tool	3850603-6	H
Rod, Nut and Washer	3855860-7	M
Pinion Bearing Remover	3850622-6	G
Seal Installer	3850627-5	G
Shimming Fixture	3850600-2	H
Shimming Ring	3850626-7	G
Spanner Wrench	3850601-0	H
Spline Socket	3850598-8	G

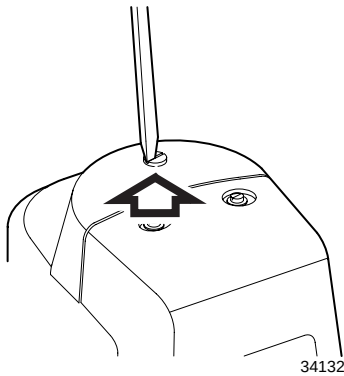
Lower Gearcase Removal

1. With the sterndrive in the full tilt down position, place a 4 quart oil drain pan under the gear case.



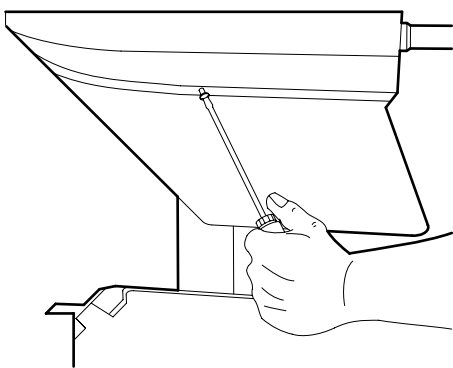
42687

2. Remove the oil level dipstick so the oil reservoir can vent while draining.

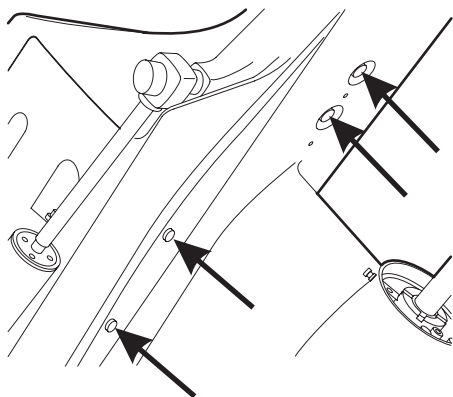


34132

3. Remove lower oil fill/drain plug. Clean off magnet and let vertical drive drain completely before removing the lower gear case.



21141

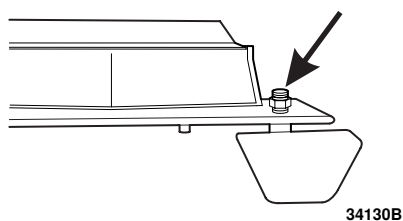


4. Use the trim/tilt system to raise sterndrive to the full tilt up position.



Caution! Be prepared to support the lower gear case. When the last screw retaining the lower gear case to the upper gear housing is removed, the lower gear case will be free to drop down.

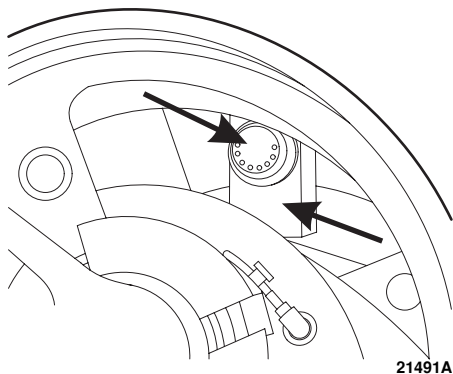
5. Remove six screws, two on either side and two aft. Pull off lower gear case assembly and mount it into a suitable holding fixture.



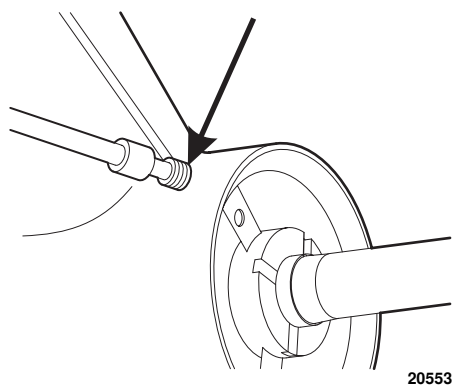
6. Mark the location of the trim tab (if one is used) with a felt-tipped marker for future reference. Remove the trim tab screw and trim tab.

Lower Gearcase Disassembly

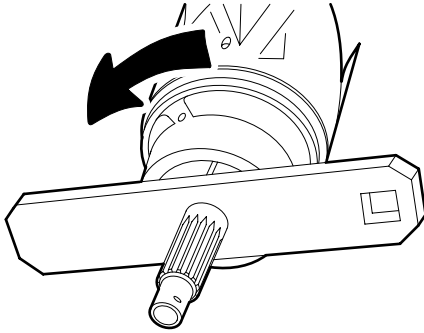
Propshaft Bearing Housing Service



1. Remove screw and inner propshaft bearing housing retainer.



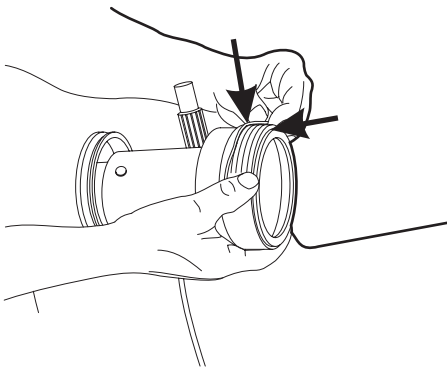
2. Remove propshaft bearing housing set screw using a Torx T-27 bit.



20551

3. Using Propshaft Bearing Housing Remover/installer, *Volvo Penta* P/N 3850707, unscrew propshaft bearing housing counter-clockwise.

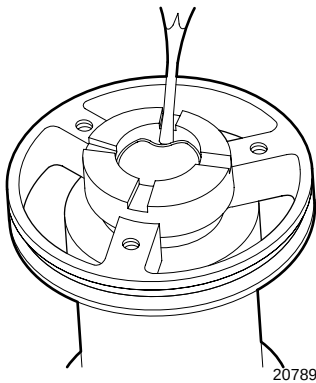
Note! Care must be used to prevent damaging the propshaft bearing housing threads. Damaged bearing housing threads can damage the internal gearcase threads making removal of the bearing housing difficult or impossible.



21483

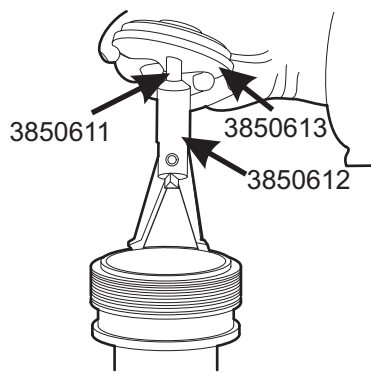
4. Remove, clean and inspect shim. It may be reused if it's not damaged. Discard O-ring.

Seal and Bearing Removal



20789

1. Use a punch and hammer to remove propshaft seal from housing. Seal will be damaged during removal and must be replaced.

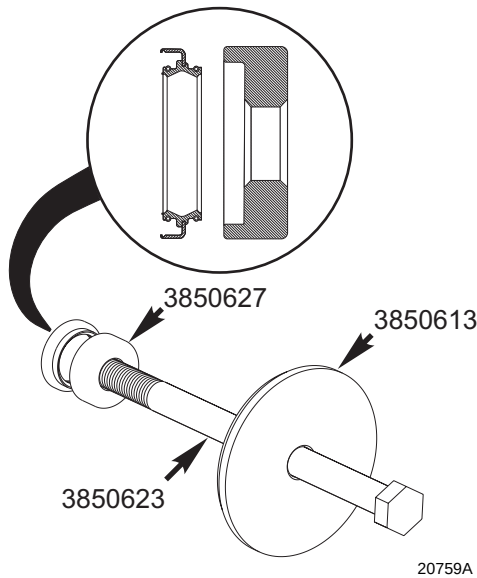


33853

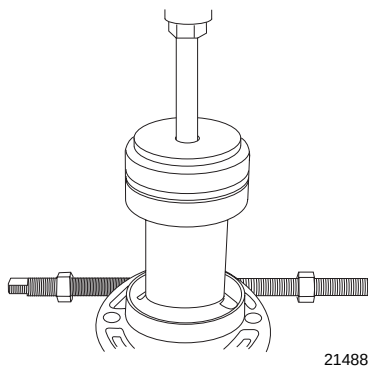
2. Attach threaded rod (from *Volvo Penta* Drive Handle, P/N 3850611) to Two Jaw Puller, *Volvo Penta* P/N 3850612. Slide Guide Plate, *Volvo Penta* P/N 3850613, stepped side facing up, onto threaded rod. Insert Puller into housing, expand jaws tightly behind bearing cup, and pull out cup.

Seal and Bearing Installation

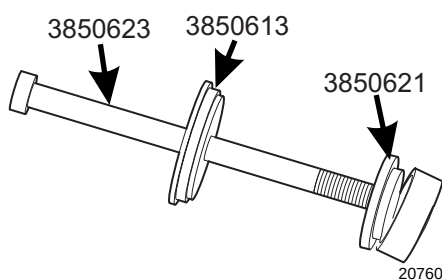
1. Clean and inspect propshaft bearing housing.



2. Assemble the Pusher/Puller, *Volvo Penta* P/N 3850623, Guide Plate, *Volvo Penta* P/N 3850613 and Seal Installer, *Volvo Penta* P/N 3850627, as shown. Face lip of seal toward tool, and slide seal onto installer.

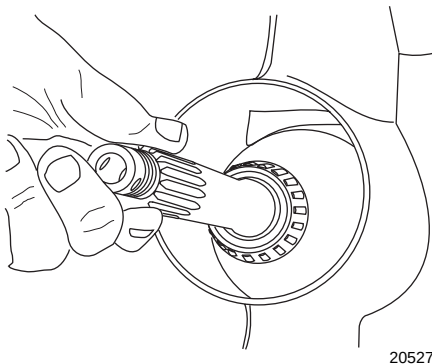


3. Apply *Volvo Penta Gasket Sealing Compound* to metal casing of seal. Press seal into bearing housing until it seats. Apply *Volvo Penta Grease* P/N 828250 to the seal lip.
4. Apply a light coat of *GL5 Synthetic Gear Lubricant SAE 75W-90* to the bearing cup.

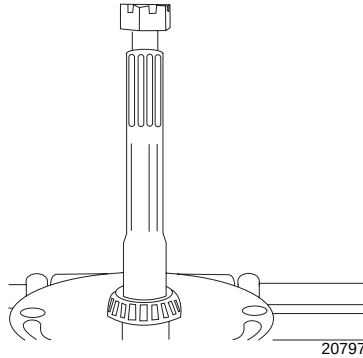


5. Using Pusher/Puller, *Volvo Penta* P/N 3850623, Guide Plate, *Volvo Penta* P/N 3850613, and Bearing Cup Installer, *Volvo Penta* P/N 3850621, press bearing cup into housing until it seats.

Propshaft Bearing Removal

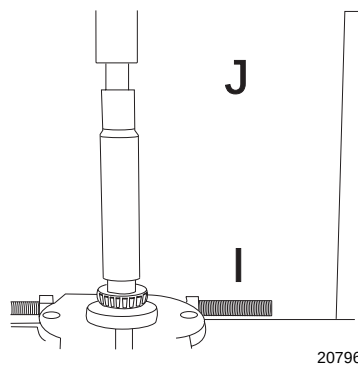


1. Pull out and inspect propshaft.



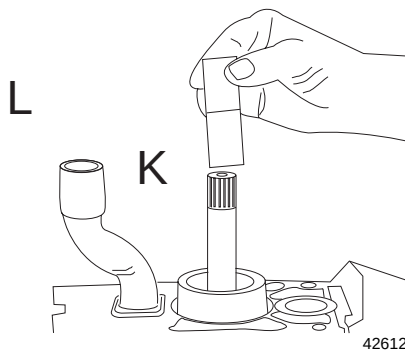
2. To remove propshaft bearing, screw propeller nut onto shaft to prevent thread damage. Support bearing in a bearing splitter and press propshaft down and out of bearing. **Be ready to catch shaft when bearing comes free.**

Propshaft Bearing Installation

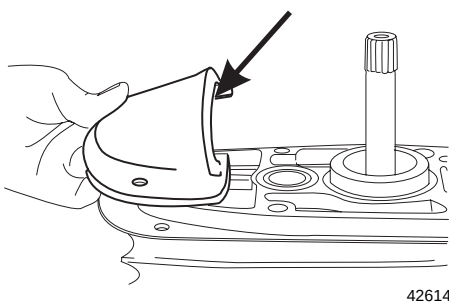


Apply a light coat of *GL5 Synthetic Gear Lubricant SAE 75W-90* to the I.D. of the bearing. Slide bearing onto propshaft with taper facing the threaded propeller nut end. Rest Bearing Installer, *Volvo Penta P/N 3850617*, on the open jaws of a press support. Position raised lip of Installer up; it must contact nose of bearing. To prevent spline damage, slide Driveshaft Holding Socket, *Volvo Penta P/N 3850618*, onto propshaft. Insert propshaft into Installer, and press propshaft into bearing until it seats.

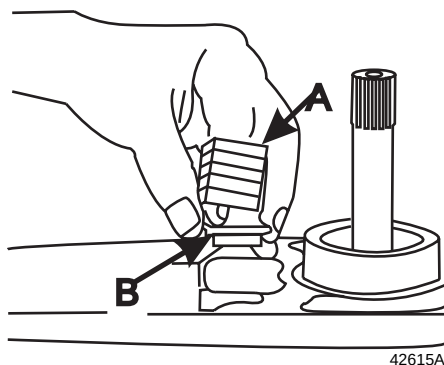
Intermediate Driveshaft and Water Tube Guide Removal



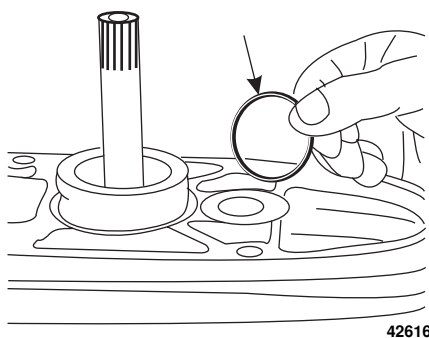
1. Remove intermediate driveshaft and inspect splines. If damaged, replace driveshaft. Remove inlet water tube and grommet. Discard grommet.



2. Remove anode and inspect it; if anode is 2/3 its original size (1/3 deteriorated), replace it.

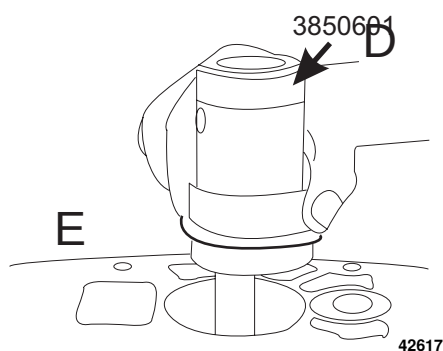


3. Remove inlet water tube seal and retainer. If seal or retainer are damaged, replace them.

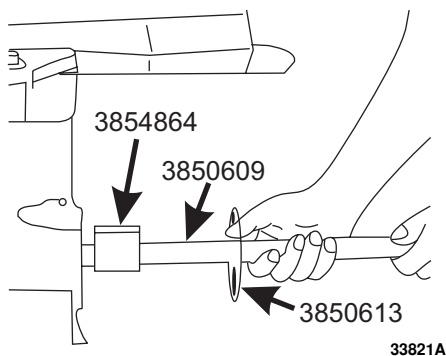


4. Remove and discard oil passage O-ring.

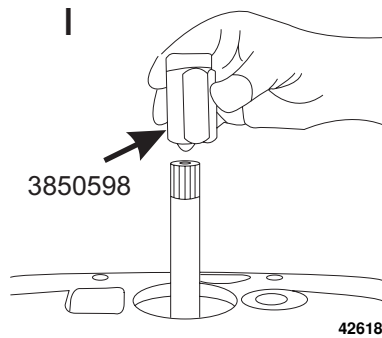
Driveshaft and Gear Removal



1. Using Spanner Wrench, *Volvo Penta* P/N 3850601, or Joint Venture P/N 3850601, unscrew retainer and O-ring. Discard O-ring.



2. Screw Pinion Nut Holder, *Volvo Penta* P/N 3854864, or Joint Venture P/N 3854864, onto Handle, *Volvo Penta* P/N 3850609. Slide Alignment Plate, *Volvo Penta* P/N 3850613, onto handle.



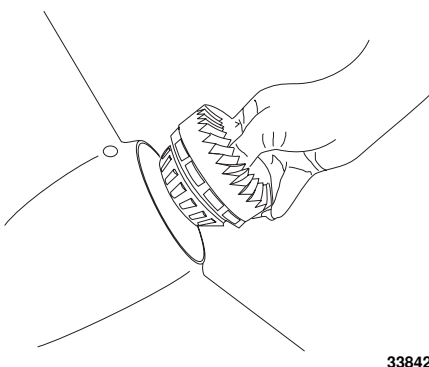
3. Insert pinion nut holder pilot into drive gear. Turn the driveshaft to align pinion nut with holder. Slide Spline Socket, *Volvo Penta* P/N 3850598 onto driveshaft.



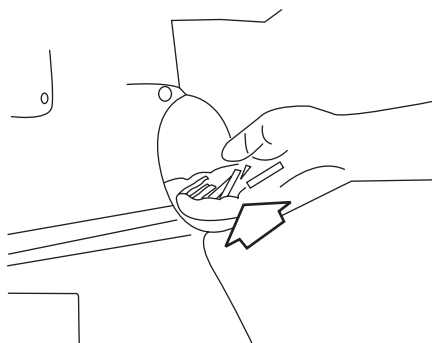
4. To remove pinion nut, turn driveshaft counter-clockwise.



5. Remove and retain pinion nut and pinion. The nut will be used later for shimming.

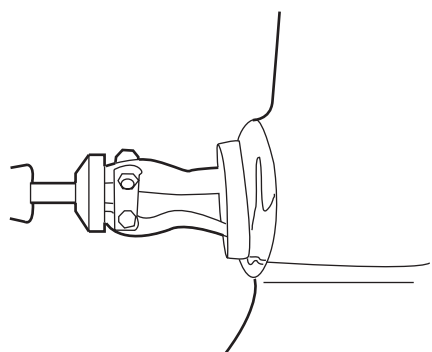


6. Lift out driveshaft assembly, then remove propeller shaft gear assembly.



21435

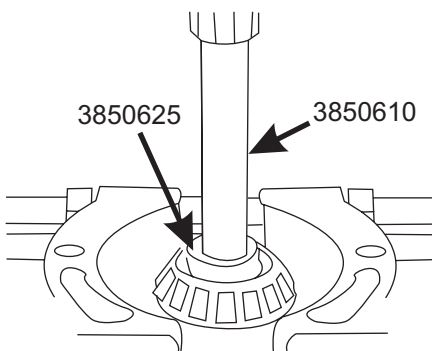
7. The 19 pinion roller bearings may fall out of the retainer; remove and retain the roller bearings.



20793

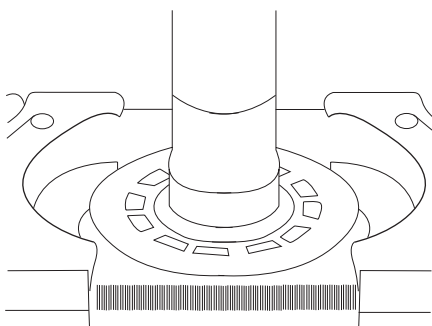
8. Use a three-jaw puller such as *Owatonna Tool*, P/N 1176, to remove the bearing cup and shims.

Note! The shims will be damaged during removal and must be replaced on reassembly.



20795

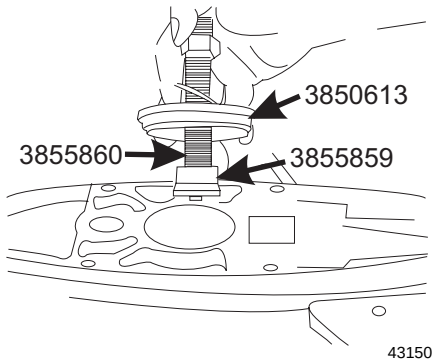
9. **Do not remove propshaft gear bearing unless you intend to replace it. Removal process may damage bearing.** Use a bearing separator to support the bearing. Insert Bearing Remover, *Volvo Penta* P/N 3850625, and Handle, *Volvo Penta* P/N 3850610, into gear, then press gear out of bearing.



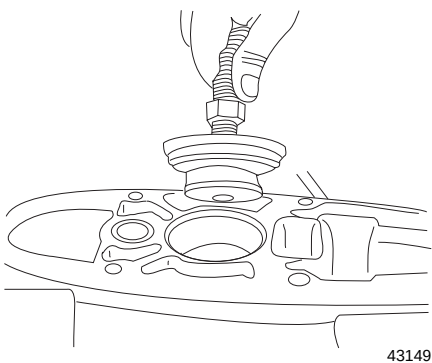
33848

10. **Do not remove oil slinger from gear unless you intend to replace it. Removal process may damage oil slinger.** Use a bearing separator to support the oil slinger, and press gear out of oil slinger.

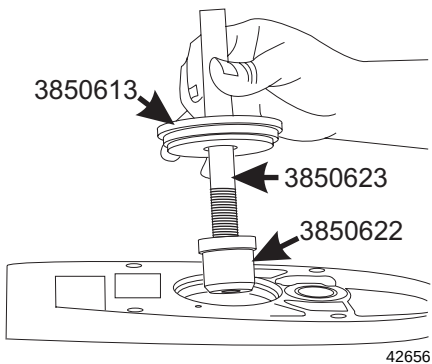
Pinion Bearing Removal



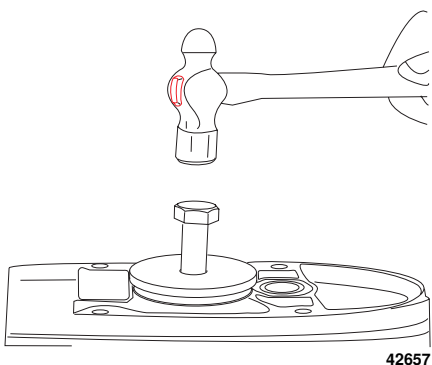
1. Assemble Remover Tip, *Volvo Penta* P/N 3855859, Rod, Nut and Washer, *Volvo Penta* P/N 3855860, and Guide Plate, *Volvo Penta* P/N 3850613. Place the remover tip into the driveshaft cavity under the lip of the lower driveshaft bearing race.



2. Tighten the nut and remove the lower driveshaft bearing race and shims. The shims may be damaged during bearing race removal and should be replaced.



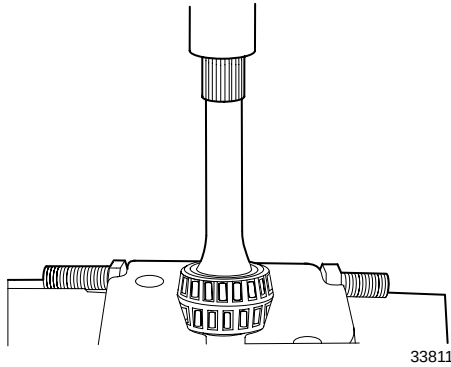
3. To remove pinion bearing, apply *Grease* to the bearing rollers and place them in the bearing case. Use Pusher/Puller, *Volvo Penta* P/N 3850623, Guide Plate, *Volvo Penta* P/N 3850613, and Remover, *Volvo Penta* P/N 3850622.



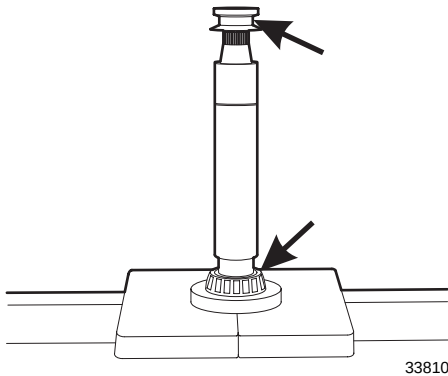
4. **Wear Safety Glasses.** Install remover into pinion bearing. Using a hammer, drive pinion bearing down and out of gearcase. Clean and inspect gearcase.

Driveshaft Bearing Removal and Installation

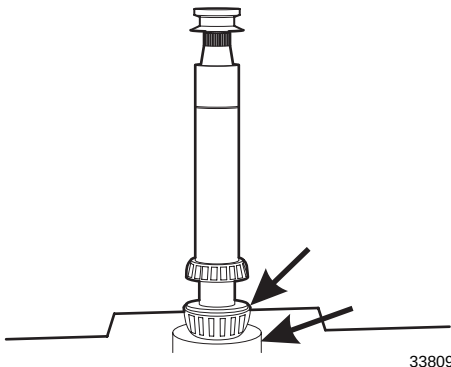
Note! Do not remove driveshaft bearings unless you intend to replace them. Removal process may damage bearings.



1. Note size, position, and direction of taper of the driveshaft bearings for reinstallation. Using a bearing separator and press, remove bearings.



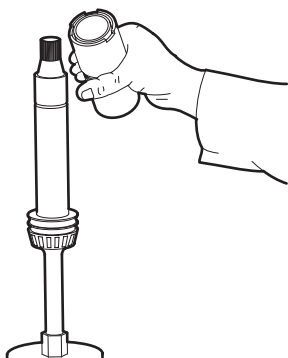
2. Apply a light coat of *GL5 Synthetic Gear Lubricant SAE 75W-90* to the I.D. of the small bearing. Protect threads of driveshaft by installing a pinion nut onto driveshaft. Slide bearing onto driveshaft with taper facing pinion end. Rest Bearing Installer, *Volvo Penta P/N 3850617*, on open jaws of a press support. Position raised lip of Installer up; it must contact backside of bearing. Insert driveshaft into Installer, and press driveshaft into bearing until it seats.



3. Apply a light coat of *GL5 Synthetic Gear Lubricant SAE 75W-90* to the I.D. of the large bearing. Slide bearing onto driveshaft with taper facing away from small bearing. Rest Bearing Installer, *Volvo Penta P/N 3850617*, on open jaws of a press support. Position raised lip of Installer up; it must contact nose of bearing. Insert driveshaft into Installer, and press driveshaft into bearing until it seats.

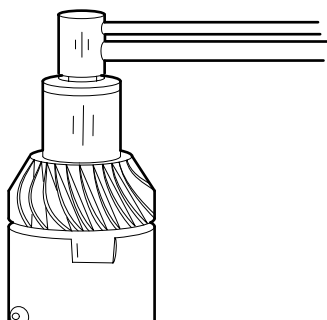
Pinion Shimming

Note! This procedure determines the amount of shims required to properly position the pinion in relation to the propshaft gear. Record the following shimming measurement for the final gear lash check.



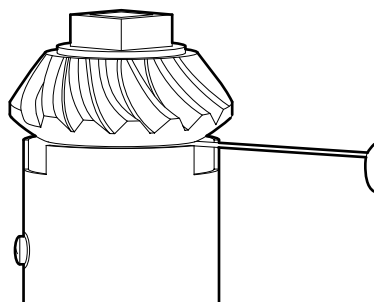
33850

1. Clamp Spline Socket, *Volvo Penta* P/N 3850598, into a vice and slide driveshaft into socket. Install small bearing cup onto bearing. Slide Pinion Shim Fixture, *Volvo Penta* P/N 3855098, onto drive-shaft with the three slots facing threaded end of driveshaft.



33813

2. Install pinion and pinion nut. Tighten pinion nut to 150-160 ft. lb. (203-217 N.m). Rotate shim fixture to seat bearing for shimming purposes.



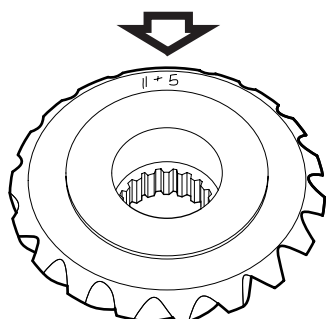
33812

3. Check all three slots with feeler gauge and record each reading. Average the three recorded feeler gauge readings by adding them together, then dividing by three.

Example:

Table 2:

Add:	Divide:
Slot no. 1 = 0.011 in.	$0.028 \text{ in.} \div 3 = 0.0093 \text{ in.}$
Slot no. 2 = 0.009 in.	(Round off to 0.009 in.)
Slot no. 3 = 0.008 in.	
Total 0.028 in.	



34792

4. Remove pinion gear and discard the nut.
5. Add or subtract the shimming allowance number etched on the gear from the number found in Step 3. If the number is etched +5, you would add 0.005 in. to the number. If the etched number is -5, you would subtract 0.005 in. from the number. If the number is zero (0), you would add or subtract nothing from the number.

Example:

Add/Subtract:

0.009 in. figure from Step 3

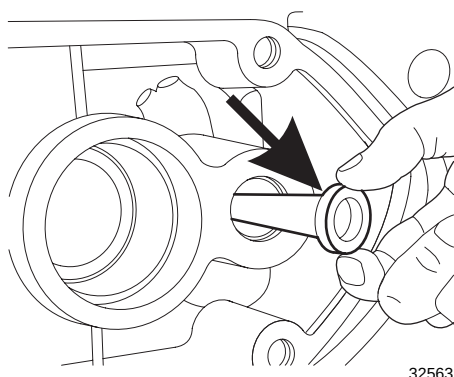
+ 0.005 in. figure etched on gear

0.014 in. shims required

6. Record dimension (example: 0.014 in.) for the pinion gear shim.

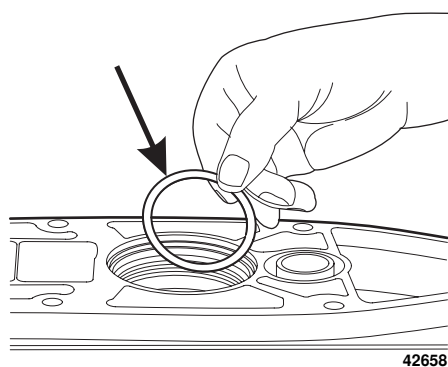
Note! No less than one shim but no more than five shims should be used to obtain the average recorded shim thickness.

Upper Gear Housing Oil Screen

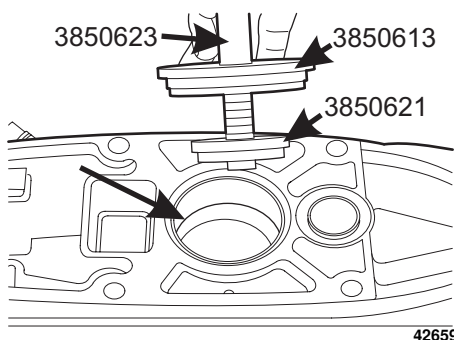


Remove the oil screen from the upper gear housing. Clean and replace as necessary. Install the oil screen into the oil passage in the upper gear housing. Make sure the screen is secure.

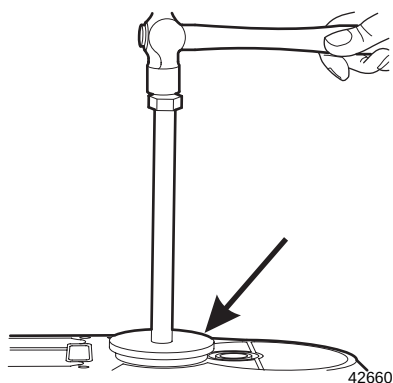
Lower Gearcase Assembly



1. The selected pinion shims are installed into the gearcase under the lower small bearing cup.



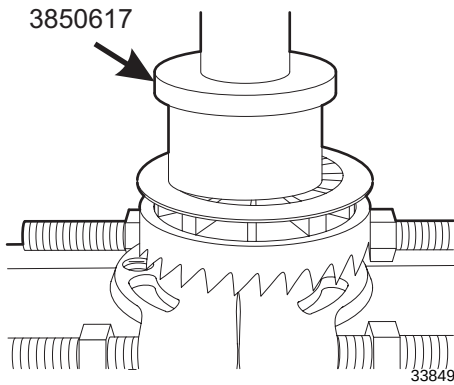
2. Apply a light coat of *GL5 Synthetic gear lubricant SAE 75W-90* to the small bearing cup. Install bearing cup on top of shims with cup taper facing up. Use Pusher/Puller, *Volvo Penta* P/N 3850623, Guide Plate, *Volvo Penta* P/N 3850613, and Bearing Cup Installer, *Volvo Penta* 3850621, to install bearing cup.



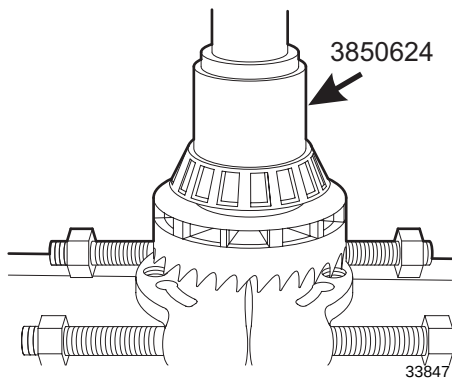
3. Place Cup Installer on cup, then seat Guide Plate onto gearcase. **Wear Safety Glasses.** Use a hammer to seat bearing cup.

Propshaft Gear - Bearing Installation

Note! This procedure determines the amount of shims required to properly position the propshaft gear in relation to the pinion. Record the following shimming measurement for the final gear lash check.

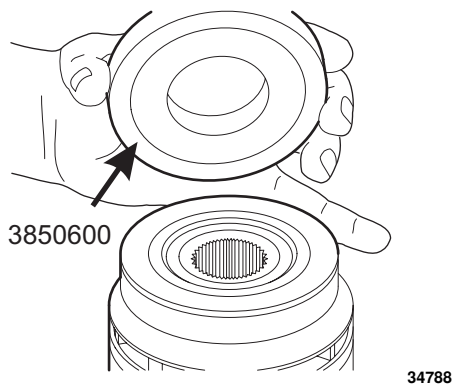


1. Apply a light coat of *GL5 Synthetic Gear Lubricant SAE 75W-90* to the propshaft gear and oil slinger. Align the pins of oil slinger with the holes of the propshaft gear. Use a suitable piece of flat stock or Bearing Separator, and Propshaft Bearing Installer, *Volvo Penta P/N 3850617*, to press oil slinger onto gear until seated.

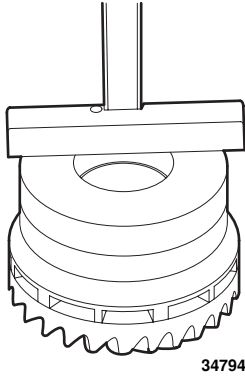


2. Apply a light coat of *GL5 Synthetic Gear Lubricant SAE 75W-90* to the bearing. Slide new bearing onto propshaft gear with taper facing away from gear. Position nose of Remover/ Installer, *Volvo Penta P/N 3850624*, onto bearing, and press bearing onto gear until it is seated.

Propshaft Gear Shimming



1. Place gear and bearing on a flat surface. Place the bearing race on top of the bearing. Rotate the race to seat the bearings. Position Shim Fixture, *Volvo Penta P/N 3850600* on top of the gear and bearing assembly, recessed side facing down.



34794

- Using a depth micrometer, measure the distance from the top of the shim fixture to the end of the gear shaft. Subtract 0.500 in. from this measurement.

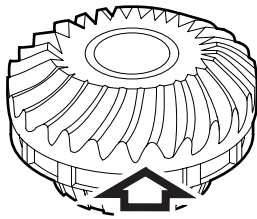
Example:

Subtract:

0.597 in. measurement to end of gear shaft

- 0.500 in. thickness of shim fixture

0.097 in. actual dimension



34791

- Add or subtract the shimming allowance number etched on the gear from the actual dimension in Step 2. If the etched number is -5, you would **SUBTRACT 0.005 in.** from the actual dimension in Step 2. If the etched number is +5, you would **ADD 0.005 in.** to the actual dimension in Step 2. If the etched number is zero (0), you add or subtract nothing from the actual dimension in Step 2.

Example:

Add/Subtract:

0.097 in. actual dimension in Step 2

0.000 in. etched number (0) on gear

0.097 in. total

- Subtract the total figure in Step 3 from a nominal dimension of 0.106 in. This new total is the number of shims required to position the propshaft gear.

Example:

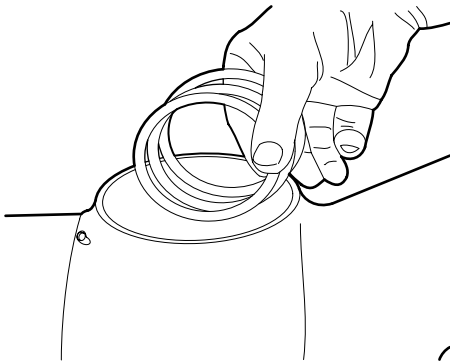
Subtract:

0.597 in. measurement to end of gear shaft

- 0.500 in. thickness of shim fixture

0.097 in. actual dimension

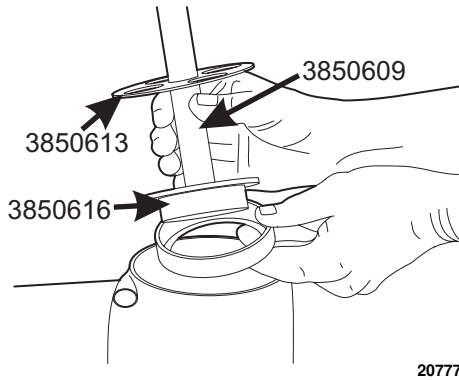
Propshaft Gear - Bearing Cup Installation



20778

- Select the correct number of shims to equal your recorded measurement. Place shims into recess of bearing cup bore.

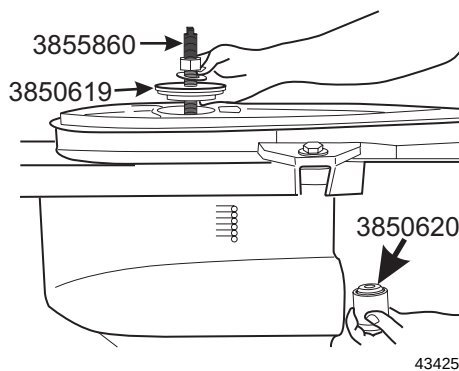
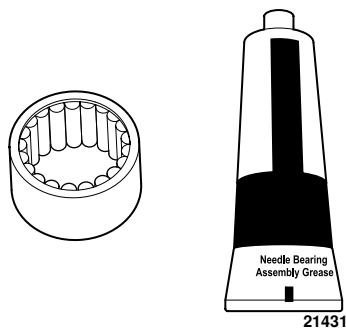
Note! No less than one shim but no more than three shims should be used.



2. Apply a light coat of *GL5 Synthetic Gear Lubricant SAE 75W-90* to the bearing cup. Place bearing cup on top of shims in lower gearcase. Screw Bearing Cup Installer, *Volvo Penta* P/N 3850616, onto Handle, *Volvo Penta* P/N 3850609-3. Slide Alignment Plate, *Volvo Penta* P/N 3850613, onto handle.

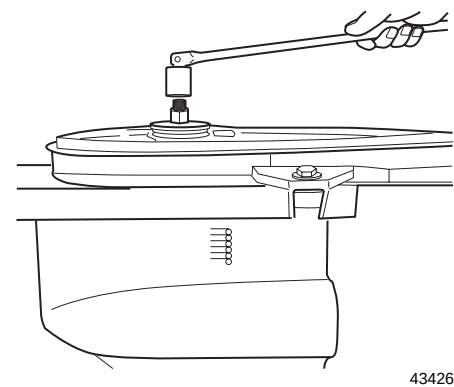
NOTE! Use a wooden 2x4 or 2x6 to cushion forward gearcase edge. Drive bearing cup in until seated.

Pinion Bearing Installation

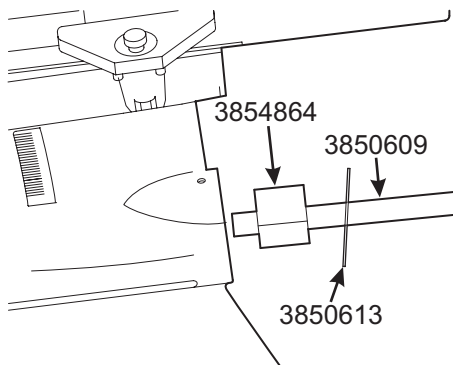


1. Apply *Volvo Penta Grease P/N 828250* to the roller bearings and install bearings into pinion bearing race.

2. Apply a light coat of *GL5 Synthetic Gear Lubricant SAE 75W-90* to pinion bearing. Install pinion bearing onto Pinion Installer, *Volvo Penta* P/N 3850620. Slide Guide Plate, *Volvo Penta* P/N 3850619, onto Rod, Nut, and Washer, *Volvo Penta* P/N 3855860. Insert rod into gearcase and screw into installer.



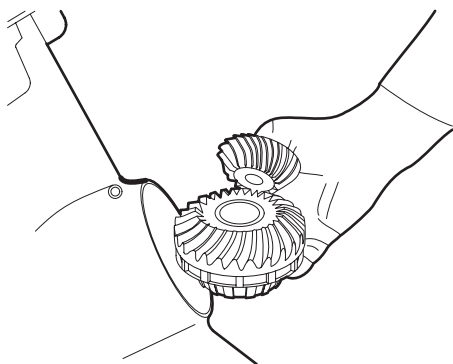
3. Turn nut until pinion bearing is seated, then unscrew and remove tools.



20730

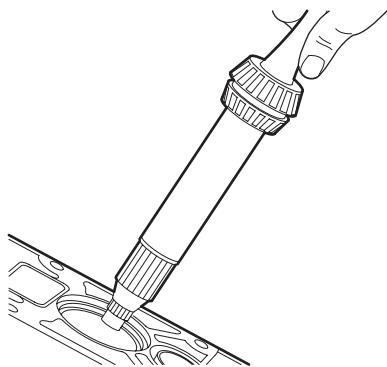
Note! If Installer turns in bearing, screw Pinion Nut Holder, *Volvo Penta* P/N 3854864, onto Handle, *Volvo Penta* P/N 3850609. Slide Alignment Disc, *Volvo Penta* P/N 3850613, onto handle. Insert into gearcase and hold pinion installer.

Driveshaft and Gear Installation



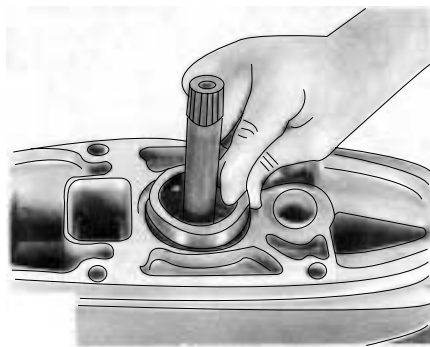
33841

1. Install propshaft gear and bearing assembly into gearcase. Position pinion above propshaft gear in gearcase pinion pocket. Engage pinion teeth with propshaft gear teeth. Install driveshaft into gearcase and engage pinion splines.



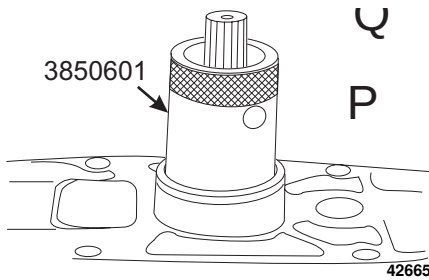
42663

Note! Insert driveshaft carefully so pinion bearing rollers aren't dislodged.

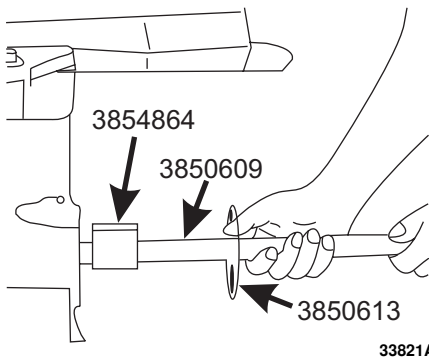


42664

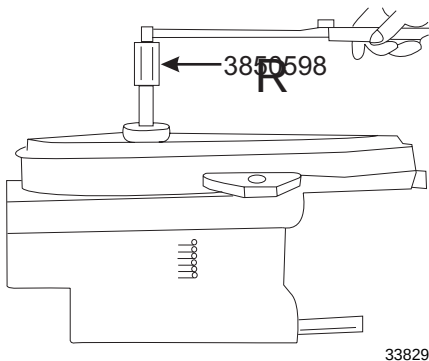
2. Apply a light coat of *GL5 Synthetic Gear Lubricant* SAE 75W-90 to the upper bearing cup. Place cup in housing, and push down until it seats on driveshaft bearing.



3. Screw in driveshaft retainer using Spanner Wrench, *Volvo Penta* P/N 3850601, and seat upper driveshaft bearing cup.



4. Apply *Loctite* Primer to the threads on the drive shaft and let air dry. Apply *Volvo Penta Thread locking compound* P/N 1161053 or adhesive to the threads. Install a new pinion nut onto driveshaft. Screw Pinion Nut Holder, *Volvo Penta* P/N 3854864, or Joint Venture P/N 3854864, onto Handle, *Volvo Penta* P/N 3850609. Slide Alignment Disc, *Volvo Penta* P/N 3850613-5, onto handle, then insert into propeller shaft gear.

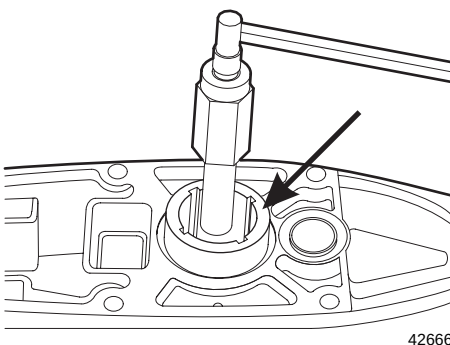


5. Install Spline Socket, *Volvo Penta* P/N 3850598, onto driveshaft and tighten pinion nut to 150-160 ft. lb. (203-217 N.m).

Setting Initial Rolling Torque

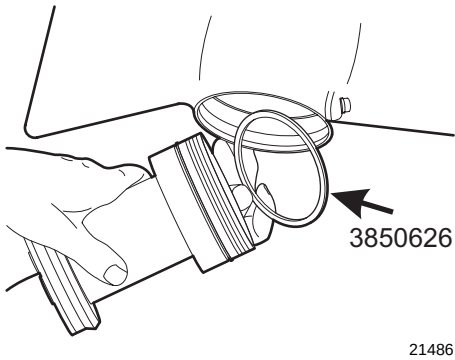
Note! This procedure will ensure bearing life by setting the driveshaft rolling torque. Turn gearcase so that propshaft bore is vertical. This will ensure the propshaft gear will not interfere with the pinion rolling torque measurement. Record the following shimming measurement for the final rolling torque setting.

1. Turn driveshaft several times to ensure bearing is seated before each torque reading.
2. Tighten driveshaft retainer to achieve a driveshaft rolling torque of 2-4 in. lb. (0,22-0,45 N.m). **Record rolling torque setting.**

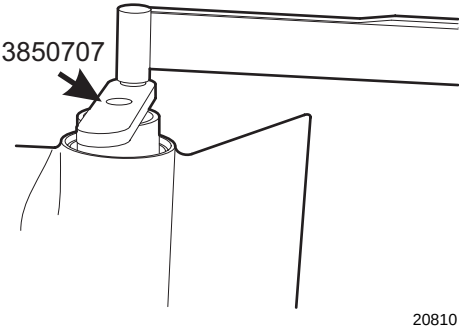


Initial Propshaft Bearing Housing
Shimming

Note! This procedure determines the amount of shims required to preload the propshaft bearings, and also ensures bearing life by setting the driveshaft/propshaft rolling torque.

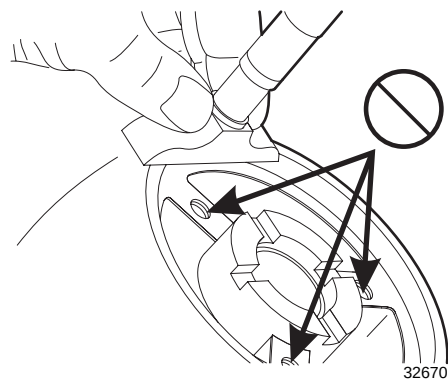


1. Apply *GL5 Synthetic Gear Lubricant SAE75W-90* to the threads of the propshaft bearing housing. Use *Volvo Penta Grease P/N 828250* to hold Shim Ring (.160 in.), *Volvo Penta P/N 3850626*, and place Shim Ring on housing. Do not install O-ring at this time.



2. Screw in propshaft bearing housing. Attach torque wrench to Housing Remover/installer, *Volvo Penta P/N 3850707*, at a 90° angle, and tighten housing to 80 ft. lb. (108,5 N.m).

Note! Record the following shimming measurement for the final gear lash check.



3. Determine depth of propshaft bearing housing. Measure from gearcase hub edge to top of each bearing housing rib. Stay away from the bolt holes. Record and average the measurements.

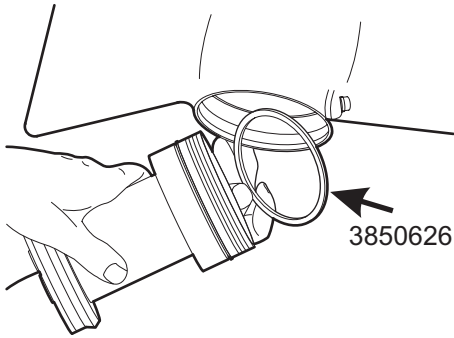
Example:

Table 3:

Add:	Divide:
Rib no. 1 = 0.403 in.	1.208 in. 3 = 0.4026 in.
Rib no. 2 = 0.407 in.	
Rib no. 3 = 0.398 in.	
Total 1.208 in.	

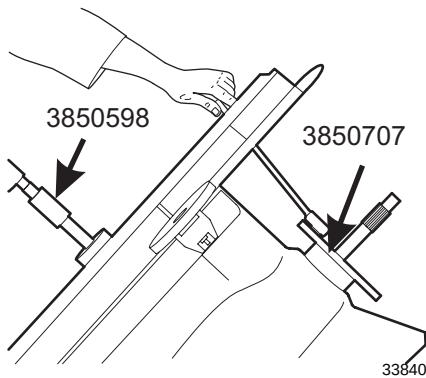
4. Round off division figure (example: 0.403 in.), and add 0.160 in. (Shim Ring, *Volvo Penta P/N 3850626*) to rounded off number (example: 0.403 in. + 0.160 in. = 0.563 in.). This result will be used later to determine the amount of shims required for the propshaft bearing housing.

5. Unscrew propshaft bearing housing and **remove Shim Ring, Volvo Penta P/N 3850626.**



21486

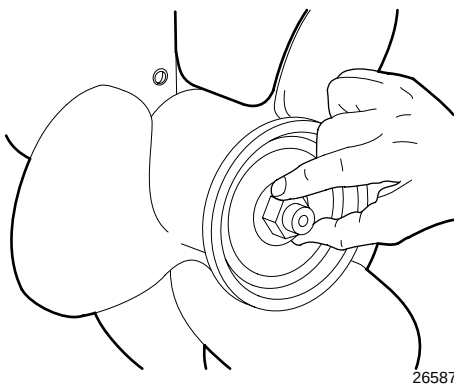
Setting Final Rolling Torque



33840

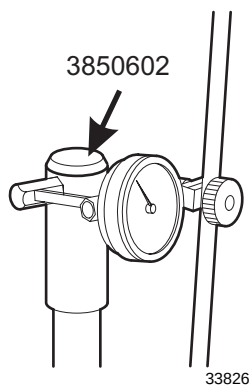
Install propshaft and bearing housing. Use Housing Remover/installer, P/N 3850707, and Spline Socket, P/N 3850598, to turn driveshaft and tighten bearing housing. This will set final rolling torque for the lower gearcase. Set rolling torque at 14-23 in. lb. (1,58-2,60 N·m) for 1.43:1, 1.51:1, 1.60:1, 1.79:1 and 1.89:1 gear ratio sterndrives and 11-18 in. lb. (1,24-2,03 N·m) for 1.66:1, 1.97:1 and 2.18:1 gear ratio sterndrives.

Gear Lash Checking



26587

1. The propeller must not turn when checking gear lash. If final rolling torque is high enough to make the propeller shaft hard to turn by hand, no additional steps are necessary. If the propeller shaft turns freely, install a propeller **without** the thrust washer. Install the brass spacer and prop nut. Tighten the prop nut **by hand** until the propshaft does not rotate freely.



33826

2. Slide Gear Lash Extension, Volvo Penta P/N 3850602, onto drive-shaft splines.
3. Clamp or hold base of dial indicator onto machined surface of gearcase. Position dial indicator perpendicular to flat surface of gauge arm. Dial indicator must contact groove on gauge arm for an accurate reading. Rotate gauge arm and dial indicator should read between 0.005-0.012 in. (0,13-0,30 mm). If a reading between 0.005-0.012 in. (0,13-0,30 mm) is obtained, remove propeller and continue to see Final Propshaft Bearing Housing Shimming on page 168.

Correcting

1. If dial indicator reading is less than 0.005 in. (0,13 mm) or more than 0.012 in (0,30 mm), all shimming operations must be remeasured. If corrections are made in the rechecking of the shimming operations, and a gear lash of 0.005-0.012 in. (0,13-0,30 mm) is obtained, continue to **see Final Propshaft Bearing Housing Shimming on page 168.**
2. If all rechecked shimming operations are the same as the original recorded shimming operations, and the recorded gear lash is still less then 0.005 in. (0,13 mm) or more then 0.012 in. (0,30 mm), continue with the following procedure:

When Gear Lash Measurement Is Less Than 0.005 in.

Subtract the gear lash measurement from 0.0085 in. (optimum gear lash measurement), and divide by two.

Example Only:

0.0085 in. Optimum gear lash measurement

- 0.003 in. Gear lash measurement

0.0055 in. Result

Divide:

0.0055 in. $\div 2 = 0.00275$ in. correction needed

Round off to nearest thousandths of an inch (i.e. 0.003 in.) if needed. This example requires the **addition of 0.003 in. shim** under the lower driveshaft bearing cup, and **0.003 in. shim removed from** behind the propeller gear bearing cup. **The optimum gear lash measurement is 0.0085 in.**

When Gear Lash Measurement Is More Than 0.012 in.

Subtract 0.0085 in. (optimum gear lash measurement) from the incorrect gear lash measurement, and divide by two.

Example Only:

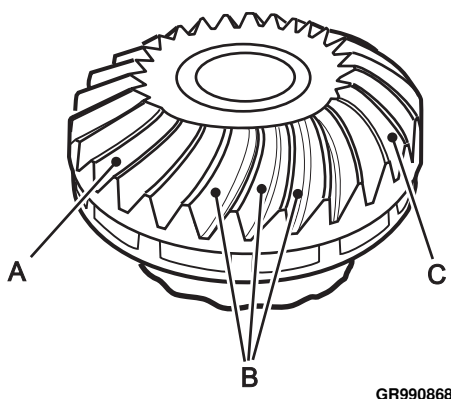
0.597 in. measurement to end of gear shaft

- 0.500 in. thickness of shim fixture

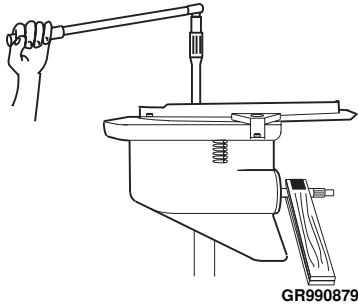
0.097 in. actual dimension

Round off to nearest thousandths of an inch (i.e. 0.003 in.) if needed. This example requires the **removal of 0.003 in. shim** from under the lower driveshaft bearing cup, and **0.003 in. added** behind the propeller gear bearing race. **The optimum gear lash measurement is 0.0085 in.**

Checking Gear Contact - SX Lower Unit



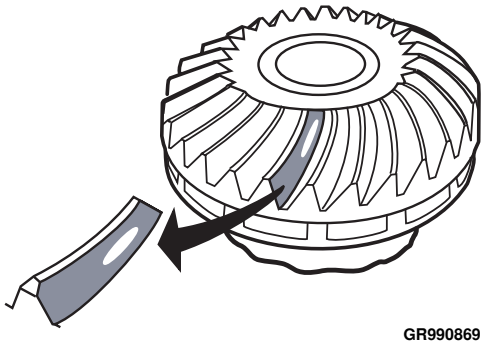
1. In order to achieve long gear life and smooth running with minimum noise, you must obtain proper gear contact pattern. The contact pattern will give you a visual clue as to where the gear teeth are meshing with each other. The pattern on the lower gear unit is checked on the convex side of the propshaft gear.
2. Paint three teeth on their convex side with gear marking compound as shown. The teeth should be completely covered with marking compound, (light coating) from heel to toe and crest to root. For drives that will be used in right hand rotation applications, use the convex side of the propeller shaft gear. For drives that will be used in left hand applications, use the concave side of the propeller shaft gear.



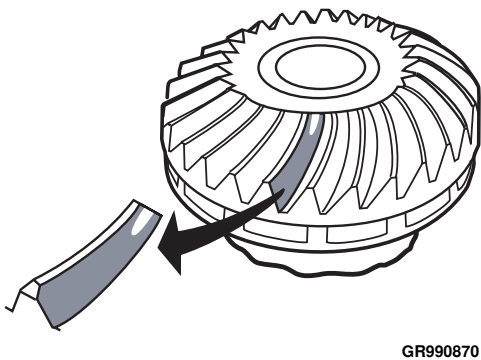
3. Then reassemble the drive according the preceding procedures. Turn the sterndrive shaft in the direction of rotation. While turning, brake the propeller shaft movement to simulate a propeller load.

If you must load the propshaft with you hands, wear leather gloves. The propeller shaft has sharp edges and may cut or injure your hands.

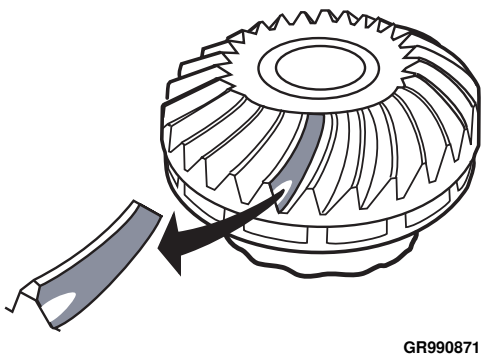
4. Remove the bearing carrier and the propshaft. Inspect the propshaft gear contact pattern.



5. Check that the contact pattern matches figure 3. The pattern should be positioned in the middle of the tooth but displaced towards the toe.

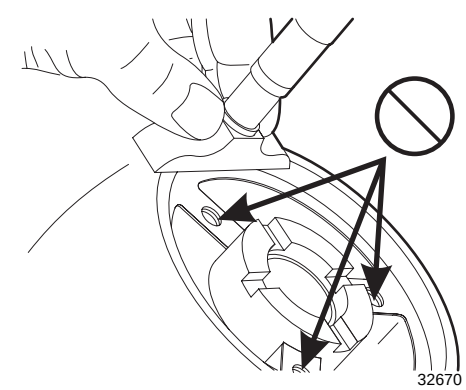


6. If the contact pattern running off the toe, **add** equal amounts of shim thickness from the propshaft and vertical shaft bearings.



7. If the contact pattern is running off the heel, **subtract** equal amounts of shim thickness from the propshaft and vertical shaft bearings.
8. Gear backlash and contact pattern must be corrected in consecutive steps. The backlash **MUST** be correct before checking the contact pattern. If adjustment is made to the shims to correct the gear contact pattern, then the backlash must be rechecked before final assembly may begin. **Clean all marking compound from gears prior to final assembly.**

Final Propshaft Bearing Housing
Shimming

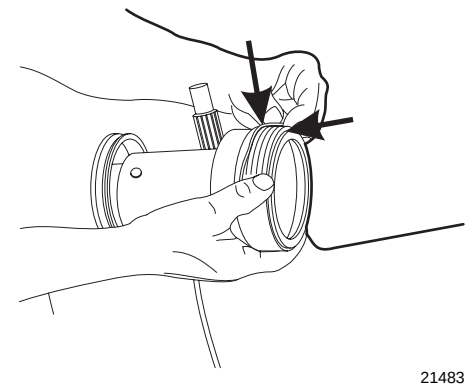


1. Determine depth of propshaft bearing housing. Measure from gearcase hub edge to top of each bearing housing rib. Stay away from the bolt holes. Record and average the measurements.

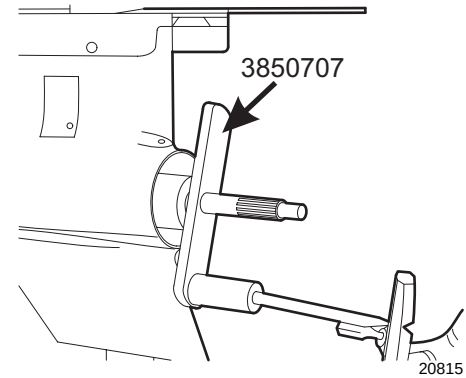
Table 4:

Add:	Divide:
Rib no. 1 = 0.403 in.	1.208 in. ÷ 3 = 0.4026 in.
Rib no. 2 = 0.407 in.	
Rib no. 3 = 0.398 in.	
Total 1.208 in.	

Subtract this figure from first recorded measurement (example: 0.563 in. - 0.445 in. = 0.118 in.). The result will be the amount of shims required for the propshaft bearing housing. A 0.118 in. shim is required for the propshaft bearing housing **in this example**.



2. Apply *GL5 Synthetic Gear Lubricant SAE 75W-90* to O-ring and threads of propshaft bearing housing. Apply *Volvo Penta Grease P/N 828250* to the selected shim ring to help hold it in place, then attach shim to bearing housing. Install assembly into gearcase.

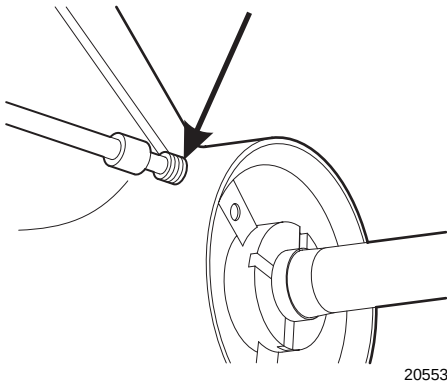


3. Install torque wrench at a 90° angle to Housing Remover/ Installer, *Volvo Penta P/N 3850707*. Tighten bearing housing to 200-225 ft. lb. (271-305 N.m). Recheck final total rolling torque to make sure it hasn't changed.

Note! If final rolling torque is too high (more than 23 in. lb. (2,6 N.m) for 1.43:1, 1.51:1, 1.60:1, 1.79:1 and 1.89:1 gear ratio vertical drives and 18 in. lb. (2,03 N.m) for 1.66:1, 1.97:1 and 2.18:1 gear ratio sterndrives), remove the propshaft bearing housing shim ring and install the next size larger shim ring. Recheck final rolling torque.

Note! If final rolling torque is too low (less than 14 in. lb. (1,58 N.m) for 1.43, 1.51, 1.60, 1.79:1 and 1.89:1 gear ratio sterndrives and 11 in. lb. (1,24 N.m) for 1.66, 1.85 and 1.97:1 gear ratio vertical drives), remove the propshaft bearing housing shim ring and install the next size smaller shim ring. Recheck final rolling torque.

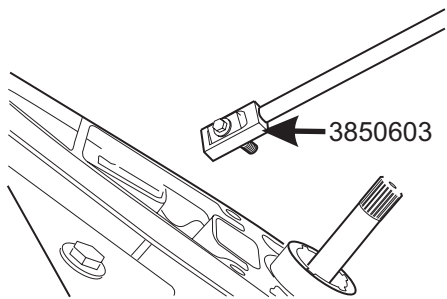
Propshaft Bearing Housing - Retainer Installation



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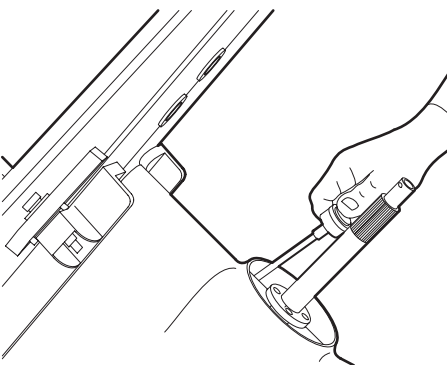
1. Apply *Loctite* Primer to set screw, let dry, then apply *Volvo Penta Thread locking compound P/N 1161053*. **Tighten set screw no more than 42-60 in. lb. (4,8-6,8 N.m).**

Note! Bearing housing lip will be distorted or broken if set screw is tightened more than recommended.



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2. Apply *Volvo Penta Gasket Sealing Compound* to the bearing housing retainer screw. Position the thickest edge of the retainer toward the handle side of the Retainer Installation Tool, *Volvo Penta P/N 3850603*. Compress the spring loaded tip as you install the retainer into the tool. Position retainer and screw inside the chamber.

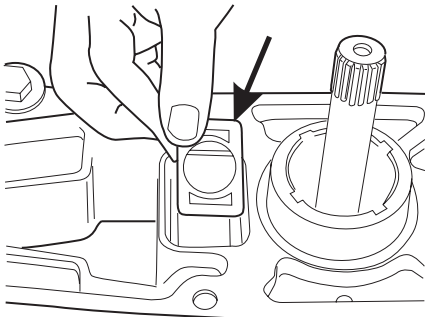


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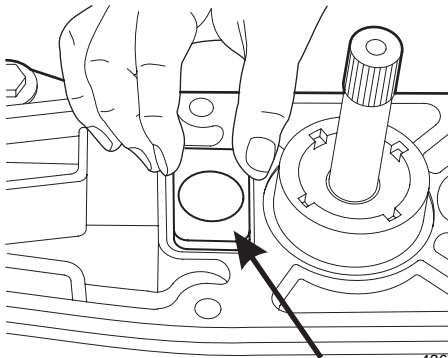
3. Use a 1/4 in drive 3/8 in. socket and extension to tighten retainer screw to 20-25 ft. lb. (27-34N•m). Remove the installation tool by pushing it towards the rear exhaust chamber.

Lower Gearcase Installation

1. Install water tube retainer. Apply *Volvo Penta Gasket Sealing Compound* to the outside of the water tube seal and install in the cavity

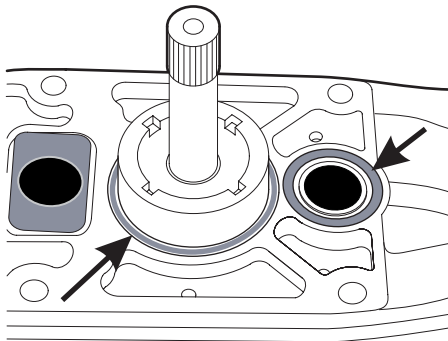


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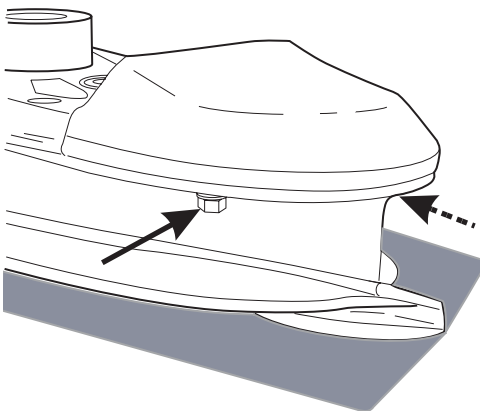
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2. Apply *GL5 Synthetic Gear Lubricant* to a new driveshaft retainer O-ring and new oil passage O-ring. Install oil passage O-ring into groove and driveshaft retainer O-ring onto retainer.



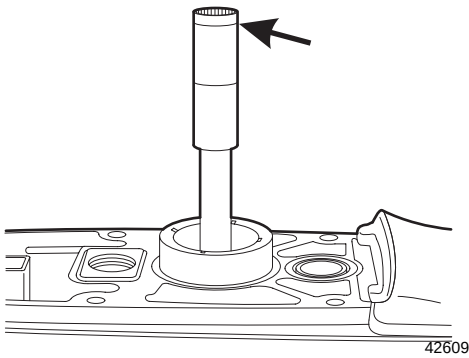
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3. Install anode and secure with two screws. Tighten the screws to 60-84 in. lb. (6,8-9,5 N.m).



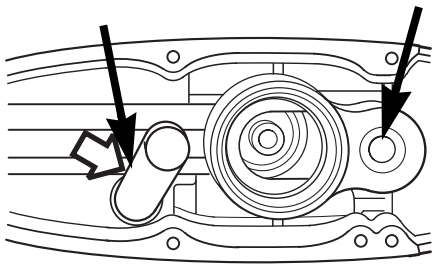
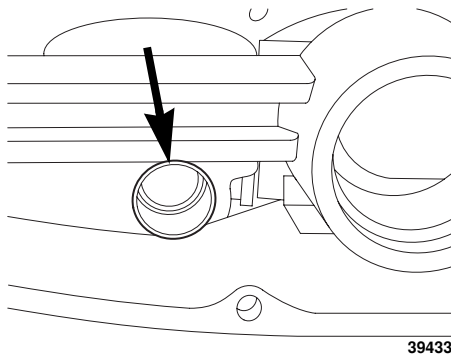
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4. Install intermediate driveshaft with the groove facing upward, onto driveshaft.

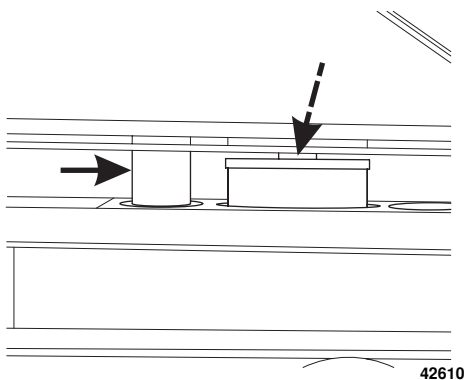


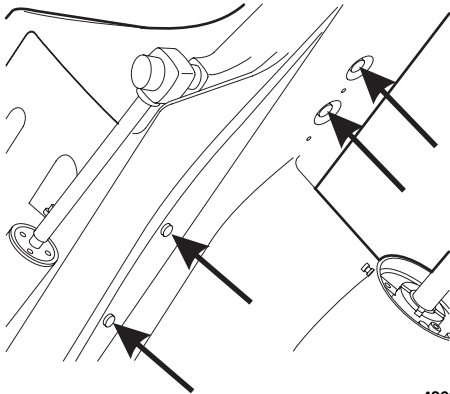
5. Install and position water grommet and supply tube into upper gear housing. Check oil filter for proper installation.

Note! Care must be used on reassembly of gearcase. If machined surface is damaged, leakage may occur.



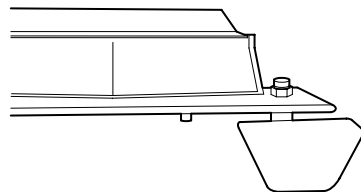
6. Attach lower gearcase to upper gear housing. Engage intermediate driveshaft splines and water supply tube.





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7. Apply *Volvo Penta Gasket Sealing Compound* to the lower gearcase mounting screws. Install four short screws, two on either side of gearcase, and two longer screws aft. Tighten 3/8-16 screws to 22-24 ft. lb. (30-33 N.m) and 7/16-14 screws to 32-40 ft. lb. (43-54 N.m).



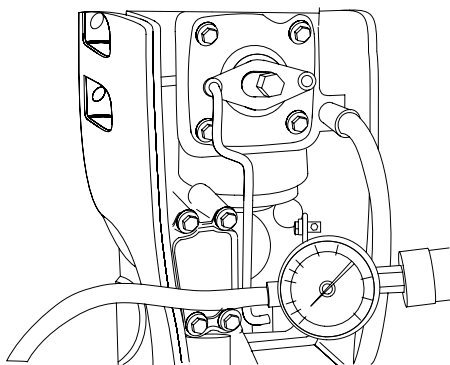
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8. Install trim tab and align with marks made during removal. Tighten mounting screw to 14-16 ft. lb. (19-22 N.m).

Pressure and Vacuum Testing Stern-drive

Before filling drive with gearcase oil, it must be pressure and vacuum tested to verify proper sealing during assembly. Remove the oil level plug at the back of the gear housing. Install and tighten oil level gauge at top of drive and the magnetic drain plug on the side of the gearcase skeg.

Pressure Testing



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1. Attach a pressure tester (such as a Stevens S-34) to the oil level hole, and pressurize drive to 3-5 PSI (20,7-34,5 kPa). Rotate propeller shaft and Universal Joint shaft to check sealing. If pressure loss is indicated, use a soapy water solution or submerge drive in water to find source. Make necessary repairs then repeat test.
2. If pressure loss is not indicated, increase pressure to 16-18 PSI (110-124 kPa). Again, use a soapy water solution or submerge in water to find source if drive loses pressure. Make repairs as necessary and repeat test. Drive must hold pressure before making vacuum test, and must not lose more than 1 PSI (6,9 kPa) in 3 minutes.

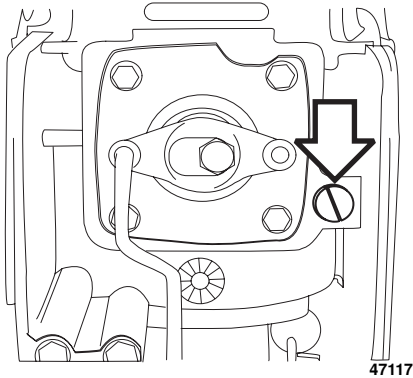
Vacuum Testing

1. Attach a vacuum tester (such as a Stevens V-34) to the oil level hole, and pull vacuum to 3-5 inches of mercury (10-16,8 kPa). Rotate propeller and Universal Joint shaft to check sealing. If drive does not hold vacuum, apply a heavy oil to seal and gasket surfaces to find source. Make necessary repairs then repeat test. No loss of vacuum should occur on low test.
2. If vacuum loss is not indicated, increase vacuum to 14-16 inches of mercury (47-54 kPa). Again, apply heavy oil to find source if drive will not hold vacuum. Make repairs as necessary and repeat test. Drive must not lose more than 1 inch of mercury (3,4 kPa) in 3 minutes.

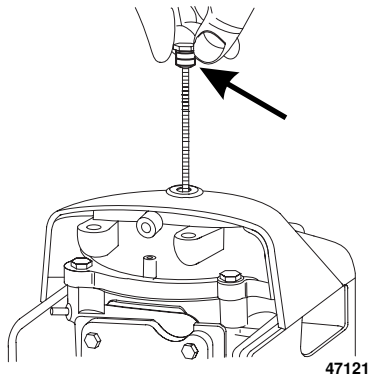
Sterndrive Filling

Note! Do not fill sterndrive with oil until it passes both pressure and vacuum tests. Drives that fail either test will allow water entry when in use and cause subsequent damage to internal parts.

1. Place drive in a vertical position. Remove the oil level plug. Also remove the level indicator gauge at top of drive to help vent the oil reservoir. Discard the plug and gauge seal. Replace them with new ones.

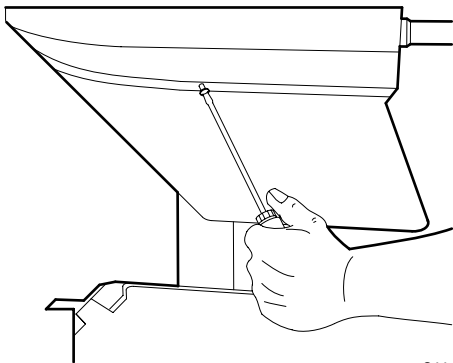


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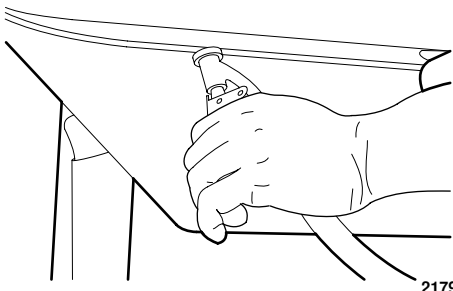
2. Remove magnetic drain screw on side of skeg. Discard screw seal and replace with a new one.



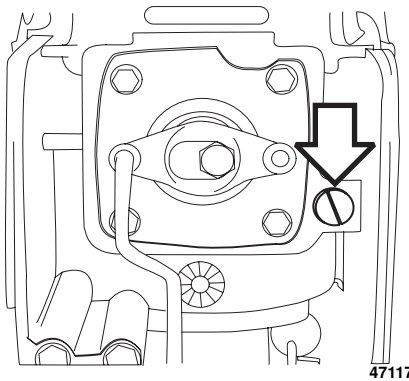
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3. Fill drive with *GL5 Synthetic Gear Lubricant 75W-90* from skeg drain hole. Fill slowly to purge trapped air. Stop filling when the oil level reaches the bottom of the oil level hole. **Do not overfill.**

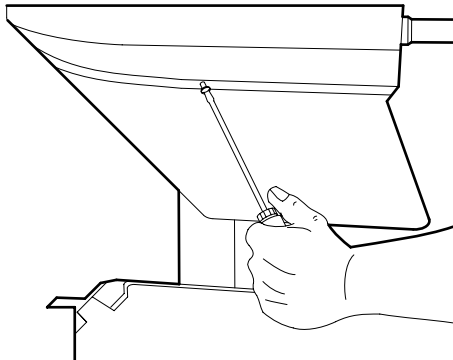
Note! Filling drive too quickly may form air pockets that will cause an inaccurate oil level reading. Running drive with improper oil level can result in immediate internal damage.



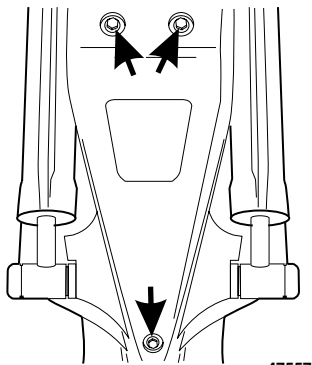
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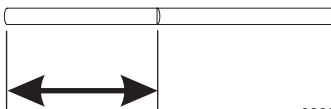
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4. When oil reaches proper level, stop filling and screw in the level plug and gauge. This will create an air lock to prevent excessive oil loss while drain plug is installed. Apply *Volvo Penta Gasket Sealing Compound* to the drain plug, and tighten to 60-84 in. lb. (6,8-9,5 N.m). Apply *Volvo Penta Gasket Sealing Compound* to the level plug and gauge. Tighten them to 48-72 in. lb. (5,4-8,1 N.m).
5. Install the sterndrive and adjust the shift system **see Sterndrive Installation on page 230.**

6. If the sterndrive is not to be installed, install the shift linkage access cover and secure with three screws. Tighten the screws to 108-132 in. lb. (12-15 N.m).

7. After drive has been run, recheck oil level. Add make-up oil through gauge opening to bring oil up to the proper level within range on the dipstick.

Anodes - Testing and Replacement

Anode erosion or disintegration in salt or brackish water indicates they're performing their function. Anodes should be inspected and/or replaced at intervals, or corrosion of the drive will increase. The lower gearcase has an anode located at the front of the gearcase above the anti-ventilation plate.

Note! If any anode has been reduced to two-thirds its original size (one-third eroded), it must be replaced.

Test for proper installation of the anode. Set an ohmmeter to the low ohms scale. Connect one ohmmeter lead to a good ground, and the other to the anode. Be sure anode surface is clean to make good contact. Ohmmeter should indicate a very low reading (zero). If not,

remove the anode and clean the mounting screws, the anode and the area where the anode is installed. Install and retest the anode.

Note! Do not paint or otherwise coat the anodes. This will prevent them from functioning properly. If anode appears to be corroded on its surface, but is not deteriorating, it should be replaced.

Specifications

Table 5:

Description	U.S.	Metric
Propshaft bearing housing	200-225 ft. lb.	271-305 N•m
Nut		
Pinion gear	150-160 ft. lb.	203-217 N•m
Screw		
Anode	60-84 in. lb.	6,8-9,5 N•m
Drain	60-84 ft. lb.	6,8-9,5 N•m
Lower to upper gearcase		
3/8-16	22-24 ft. lb.	30-33 N•m
7/16-14	32-40 ft. lb.	43-54 N•m
Oil level gauge and plug	48-72 in. lb.	5,4-8,1 N•m
Retainer, propshaft bearing housing	20-25 ft. lb.	27-34 N•m
Set screw, propshaft bearing housing	42-60 in. lb.	4,8-6,8 N•m
Shift Linkage Access Cover	108-132 in. lb.	12-15 N•m
Trim tab to gearcase	14-16 in. lb.	19-22 N•m

Sealants, Lubricants and Adhesives

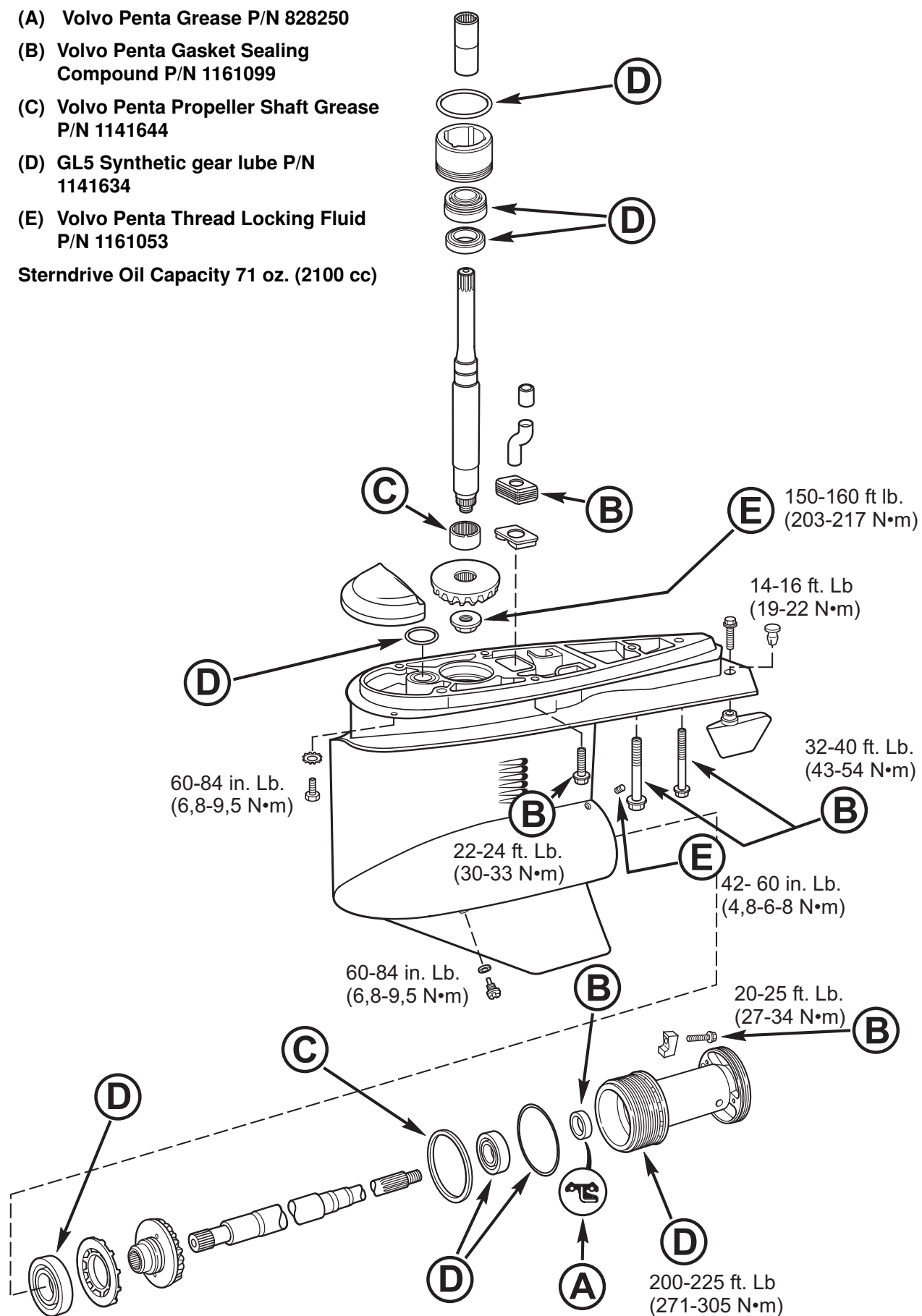
Table 6:

Type	Chemical	Where Used
Primer	<i>Loctite</i> Primer	Lower driveshaft (pinion nut) threads Set screw, propshaft bearing housing
Adhesive	<i>Volvo Penta Thread Locking Fluid</i> P/N 1161053	Set screw, propshaft bearing housing
Lubricants	Volvo Penta Grease P/N 828250	Seal lips Shim ring, propshaft bearing housing
	GL5 Synthetic Gear Lubricant SAE 75W-90	Threads, propshaft bearing housing O-ring, forward oil passage O-ring, driveshaft bearing retainer
Sealants	Volvo Penta Gasket Sealing Compound	O.D. all metal case seals Gauge and plug, gearcase oil level Screw, drain Screws, lower to upper gearcase Screw, propshaft bearing housing retainer Seal, water tube

Service Chart

- (A) Volvo Penta Grease P/N 828250
- (B) Volvo Penta Gasket Sealing Compound P/N 1161099
- (C) Volvo Penta Propeller Shaft Grease P/N 1141644
- (D) GL5 Synthetic gear lube P/N 1141634
- (E) Volvo Penta Thread Locking Fluid P/N 1161053

Sterndrive Oil Capacity 71 oz. (2100 cc)



Notes

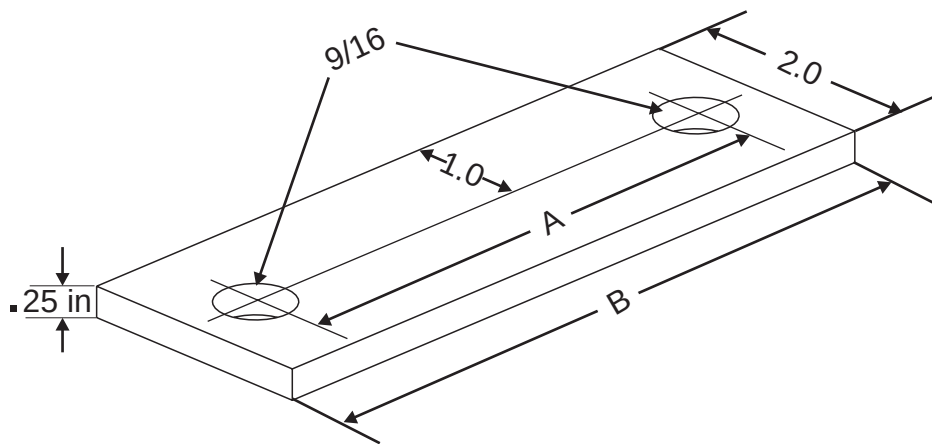
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DP-S Lower Gearcase

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Safety Warnings Before working on any part of the lower gearcase, read the section called Safety at the end of this manual. Several of the following procedures require the use of an arbor or hydraulic press. Always wear safety glasses when using this device to perform these procedures.

Gearcase Retaining Plate

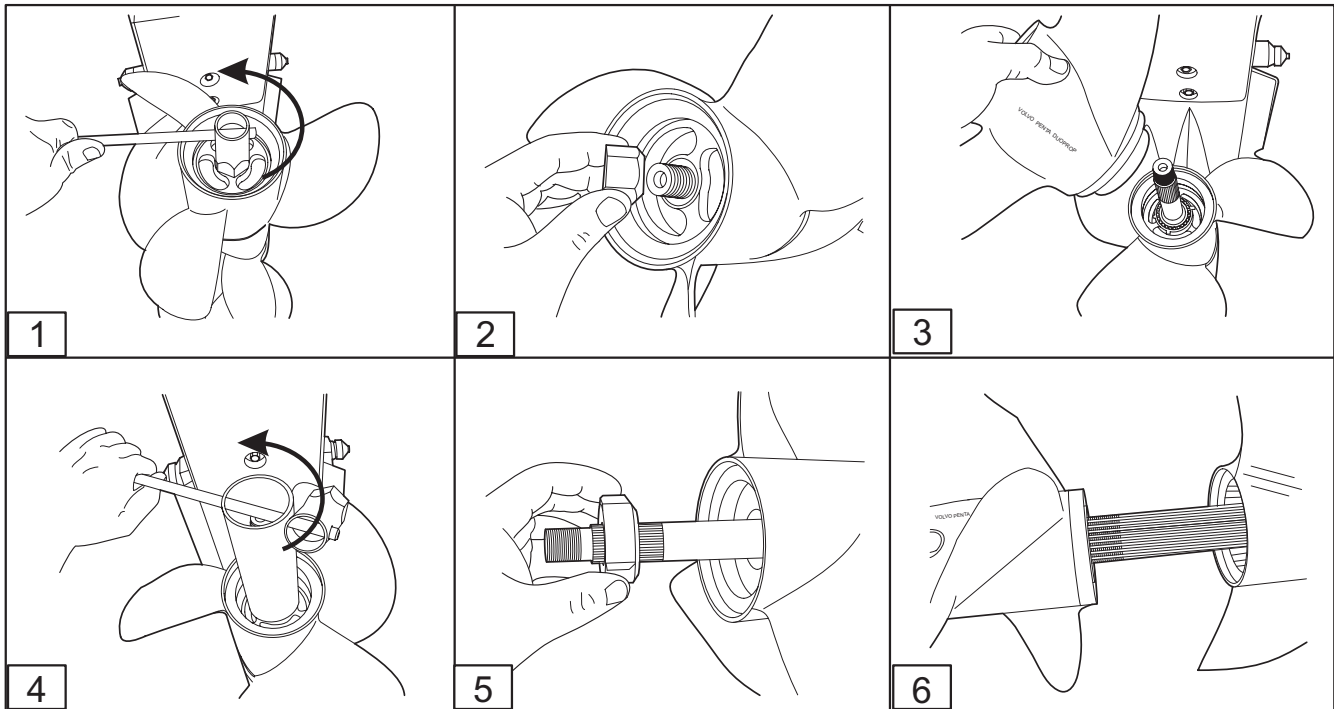


A gearcase retaining plate can be made from $\frac{1}{4}$ in. steel, or $\frac{3}{8}$ in. aluminum, following the dimensions given, to work with most large lower gearcase holding fixtures. Dimension (distance between bolt centerlines) should be taken from your holding fixture. Dimension is dimension + $1 \frac{1}{4}$ in. Longer screws ($4 \frac{1}{2}$ in.) are also required. Use the existing nuts and washers from the fixture.

Special Tools

Table 1:

Tool Name	Volvo P/N	Panel Location	Tool Name	Volvo P/N	Panel Location
Attachment Tool	884940	*	Rod, Nut and Washer	3855860	M
Bearing and Sleeve Installer	3855866	M	Seal and Bearing Installer	3855925	L
Bearing Cup Installer	3850621	G	Seal and Bearing Remover	3855924	L
Bearing Installer	3850617	G	Shim Fixture	3850600	H
Bearing Installer	3855861	M	Shim Fixture	3855870	M
Bearing Installer	3855928	L	Shim Fixture	3855871	M
Dismantling Tool	884803	L	Shim Fixture	3855872	M
Drift	884143	L	Sleeve Installer	3855869	M
Driveshaft Puller	3855923	L	Spacer	3855867	M
Fill Adaptor	3855932	L	Spanner Wrench	3850601	H
Front Propeller Remover/Installer	3855876	L	Spanner Tool	3855877	L
Guide Plate	3850619	G	Spline Socket	3850598	H
Guide Plate	3855863	M	Standard Shaft	9991801	H
Installation Tool	884975	L	Support Base	3855926	L
Lash Tool	3855873	M	Tube	3855922	L
Nut	3855920	L	Note! Special tools are available from <i>Volvo Penta Parts</i> individually or in service level kits. The Level 1 Kit, <i>Volvo Penta P/N 3855955</i> , includes all the tools necessary to properly disassemble and reassemble the DP-S lower gearcase for reseal and inspection. The Level 2 Kit, <i>Volvo Penta P/N 3856041-3</i> , contains all the fixtures required to properly shim the DP-S lower gearcase when bearings or gear sets have been changed. The Level 2 Kit must be used in conjunction with the Level 1 Kit to disassemble, shim and reassemble the DP-S lower gearcase.		
Pinion Nut Holder	3855930	L			
Propeller Shaft Adaptor	3855919	L			
Protection Sleeve	884807	L			
Protection Sleeve	884976	L			
Puller	884832	M			
Puller	884789	L			
Pusher Tip	3855921	L			
Race Installer	3855864	M			
Race Installer	3855865	M			
Race Remover	3855862	M			
Remover and Installer Tip	3855868	M			
Remover Tip	3855859	M			



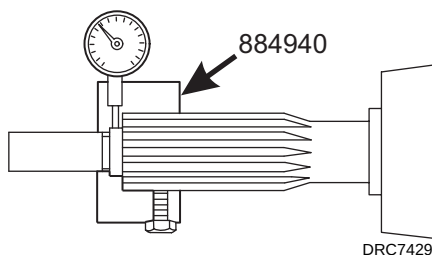
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Propeller Shaft Runout

Remove Propellers

1. Move the shift lever to **REVERSE**. (1) Remove the rear propeller retaining nut and propeller using a 30 mm socket. Move the shift lever to **FORWARD**. (4) Remove the front propeller retaining nut and propeller using Front Propeller Remover/Installer, Volvo Penta P/N 3855876.

Note! Do not attempt to hold the propellers by hand while removing propeller nuts, serious injury may result.

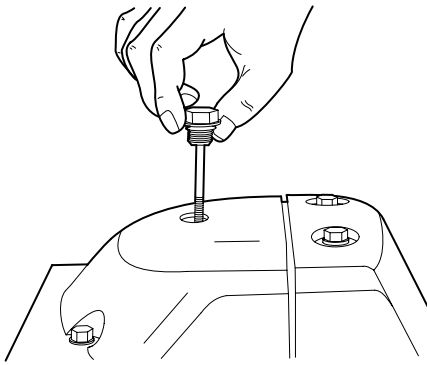


2. Attach a dial indicator to Special Tool, Volvo Penta P/N 884940 and attach to the outer propshaft with the tip resting on the inner propshaft as close to the edge of the outer propshaft as possible.
3. Rotate the shaft one turn and read off the throw on the dial indicator. The Reading should not exceed 0.0027 in. (0,07 mm).
4. To measure the play in the propeller shaft, move the inner propshaft toward and away from the dial indicator. Check the shaft in several different positions. The play between shafts should not exceed 0.0012 in. (0,03 mm).

Lower Gearcase Removal

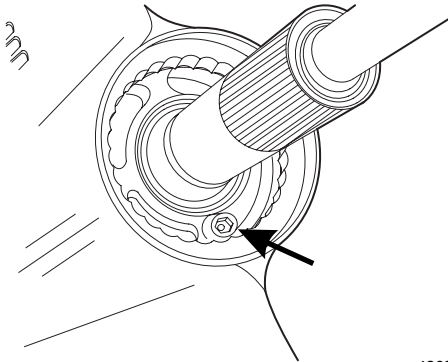
1. With the sterndrive in the full tilt down position, place a 4 quart oil drain pan under the gearcase.

2. Remove the oil level dipstick so the oil reservoir can vent while draining.

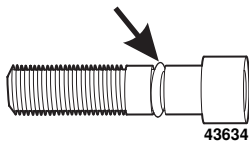


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3. Remove oil fill/drain screw using an 8 mm Allen wrench.



43635

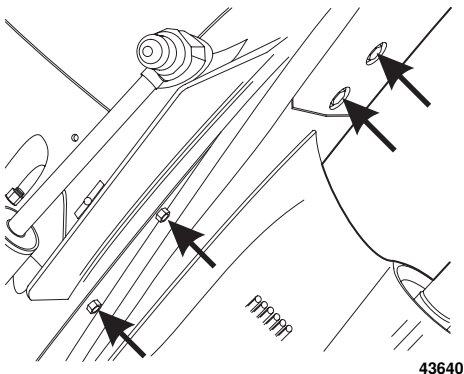


43634

4. Discard the O-ring. Let the sterndrive drain completely before removing the lower gearcase.
5. Use the trim/tilt system to raise sterndrive to the full tilt up position.

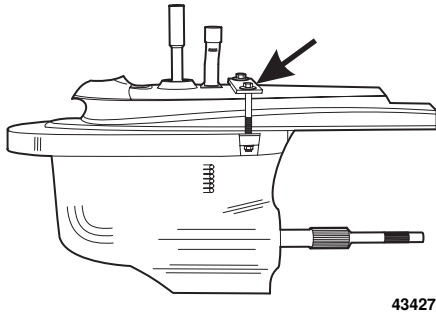
Be prepared to support the lower gearcase. When the last fastener retaining the lower gearcase to the upper gear housing is removed, the lower gearcase will be free to drop down.

6. Remove four nuts, two on either side and two screws. Pull off lower gearcase assembly.



43640

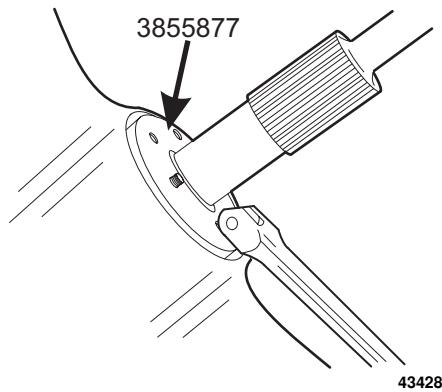
7. Mount the lower gearcase in a suitable holding fixture. Retain the gearcase with the plate and longer screws described on **Page 5-2**.



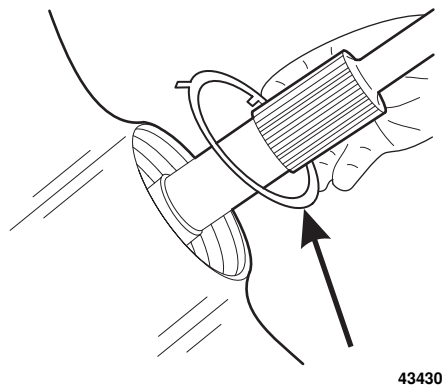
Lower Gearcase Disassembly

Propeller Shaft Housing Propeller Shaft Removal

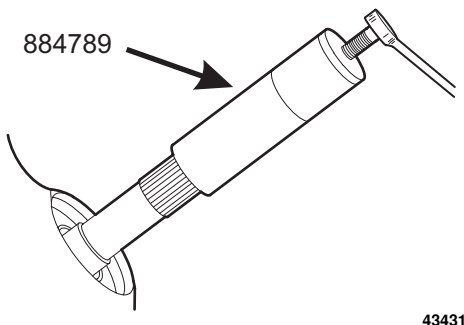
1. Remove retaining ring using Spanner Tool, *Volvo Penta* P/N 3855877. Remove and discard both O-rings.



2. Remove the bearing housing retainer.

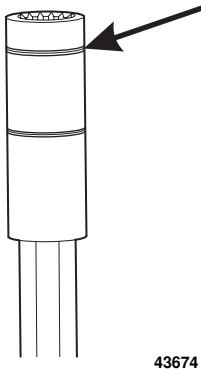


3. Thread Puller, *Volvo Penta* P/N 884789, onto the end of the outer propeller shaft. Tighten the 5/8-11 bolt to remove the outer propeller shaft and propeller shaft housing from the lower gearcase. Remove the puller, then remove the outer propeller shaft from the propeller shaft housing. Remove and discard all O-rings on the housing.

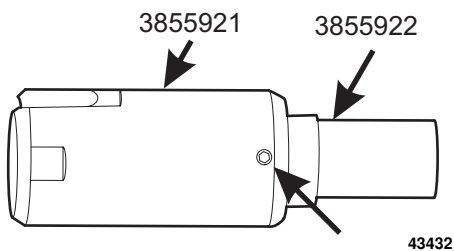


Inner Propeller Shaft Removal

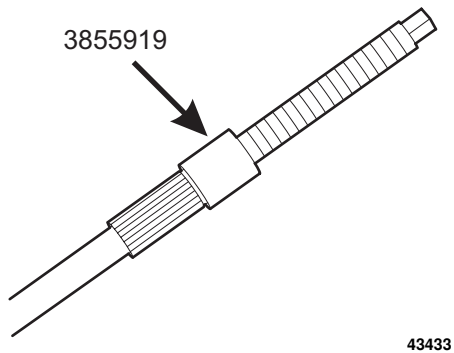
1. Remove intermediate driveshaft and inspect splines. If damaged, replace driveshaft.



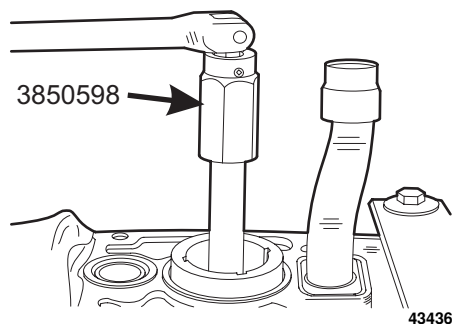
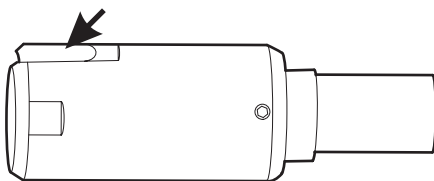
2. Assemble Pusher Tip, *Volvo Penta* P/N 3855921, and Tube, *Volvo Penta* P/N 3855922. Tighten set screw securely.

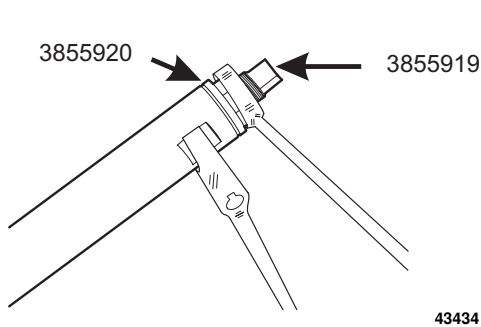


3. Thread Propeller Shaft Adaptor, *Volvo Penta* P/N 3855919 onto the end of the inner propeller shaft.

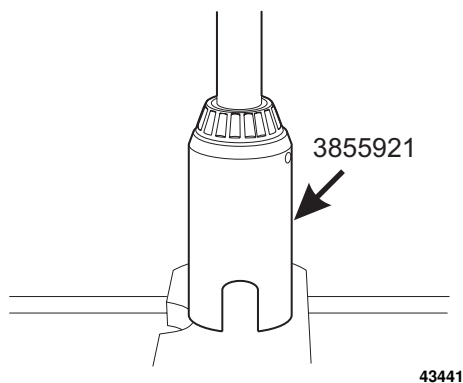


4. Slide the assembled tools over the inner propeller shaft. Align the notch in the end of the Pusher Tip with the pinion nut. Turn the sterndrive shaft to help the alignment. Seat the tools onto the forward gear. Place Spline Socket, *Volvo Penta* P/N 3850598 onto the vertical driveshaft. Loosen the pinion nut several turns, but do not remove it at this time.



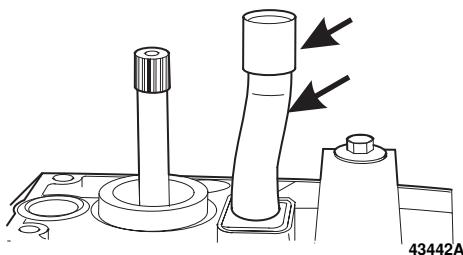


5. Apply grease to the end of the tube. Thread Nut, *Volvo Penta* P/N 3855920 onto the adaptor. Tighten the nut to remove the inner propeller shaft from the forward gear. Remove the tools from the shaft.

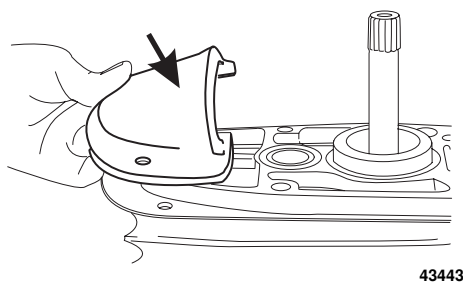


6. Place Pusher Tip, *Volvo Penta* P/N 3855921 in a press with the notch facing down. Place the inner propeller shaft into the Pusher Tip. Thread a used rear propeller nut onto the shaft to protect the threads. Press the small tapered bearing off the shaft. Remove the shims. They may be reused if they are not damaged.

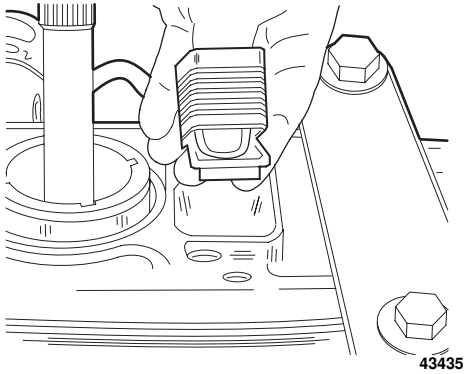
Water Tube Guide and Anode Removal



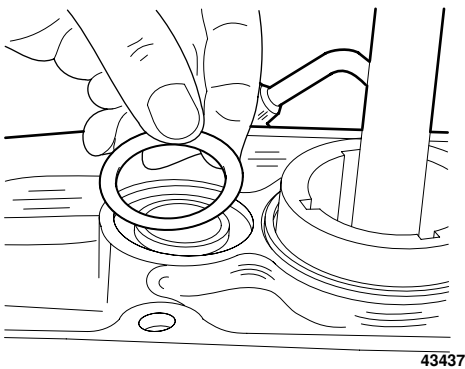
1. Remove inlet water tube and grommet. Discard grommet.



2. Remove anode and inspect it; if anode is $\frac{2}{3}$ its original size ($\frac{1}{3}$ deteriorated), replace it.



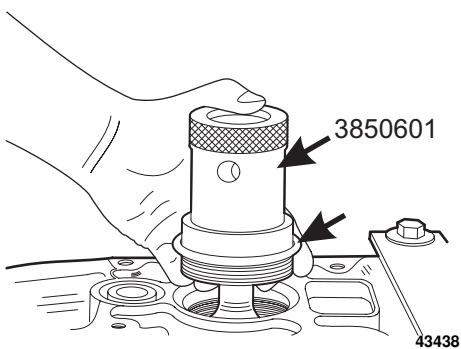
3. Remove inlet water tube seal and retainer. If seal or retainer are damaged, replace them.



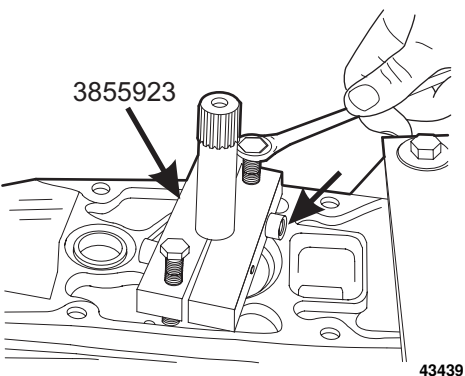
4. Remove and discard oil passage O-ring.

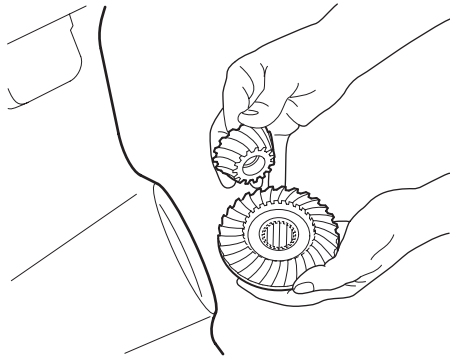
Driveshaft and Pinion Removal

1. Remove the pinion nut from the vertical driveshaft. Retain the nut for shimming the vertical driveshaft.
2. Remove the driveshaft bearing retainer using Spanner, *Volvo Penta* P/N 3850601. Remove and discard the O-ring.



3. Place Driveshaft Puller, *Volvo Penta* P/N 3855923 onto the driveshaft. Tighten two Allen head set screws securely. Tighten the two screws alternately to remove the driveshaft from the pinion. Remove the driveshaft from the gearcase.



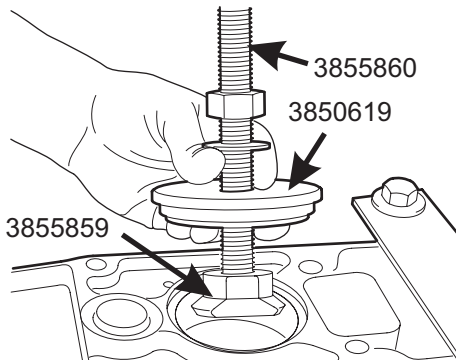


43456

4. Remove the forward gear and bearing and pinion from the gearcase.

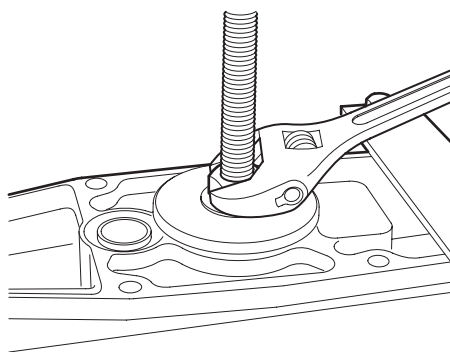
Gearease Bearing and Race Removal

Lower Driveshaft Bearing



43457

1. Assemble Remover Tip, *Volvo Penta* P/N 3855859, Rod, Nut and Washer, *Volvo Penta* P/N 3855860, and Guide Plate, *Volvo Penta* P/N 3850619. Place the remover tip into the driveshaft cavity under the lip of the lower driveshaft bearing race.

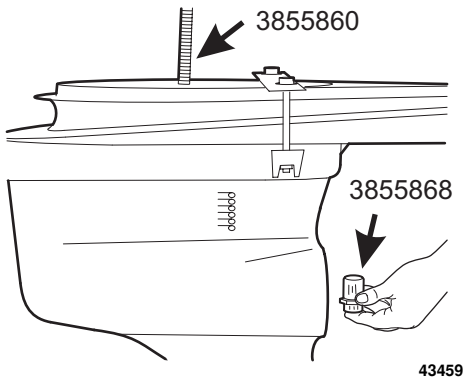


43458

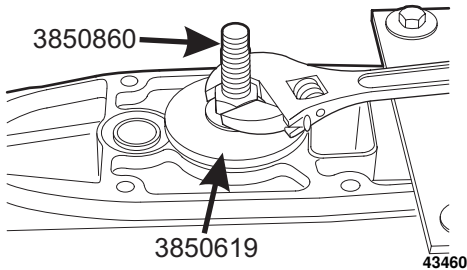
2. Lightly oil the threads of the rod. Tighten the nut and remove the lower driveshaft bearing race and shims. The shims may be damaged during bearing race removal and should be discarded.

Pinion Bearing

Note! Remove the pinion bearing only if it is to be replaced. The bearing may be damaged during removal.

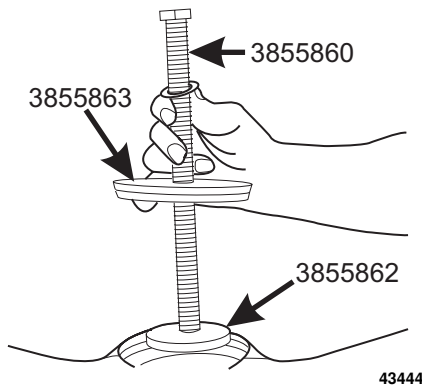


1. Place Remover/Installer Tip, *Volvo Penta* P/N 3855868 into the pinion bearing. Thread the rod from Rod, Nut and Washer, *Volvo Penta* P/N 3855860 into the remover/installer tip.

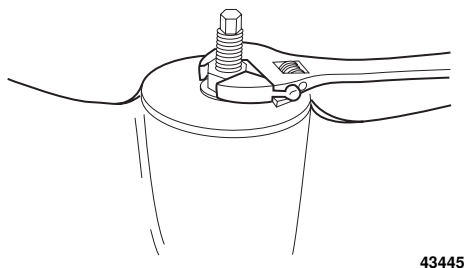


2. Place Guide Plate, *Volvo Penta* P/N 3850619, over the rod and into the driveshaft bore. Lightly oil the threads of the rod. Place washer and nut from Rod, Nut and Washer, *Volvo Penta* P/N 3850860 onto the rod. Tighten the nut to remove the pinion bearing.

Forward Bearing Race



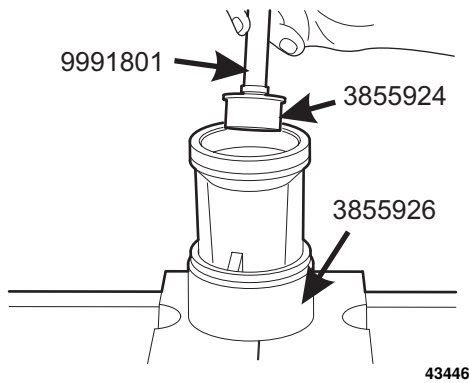
1. Assemble Race Remover, *Volvo Penta* P/N 3855862, or Joint Venture P/N 3855862, Rod, Nut and Washer, *Volvo Penta* P/N 3855860 and Guide Plate, *Volvo Penta* P/N 3855863.



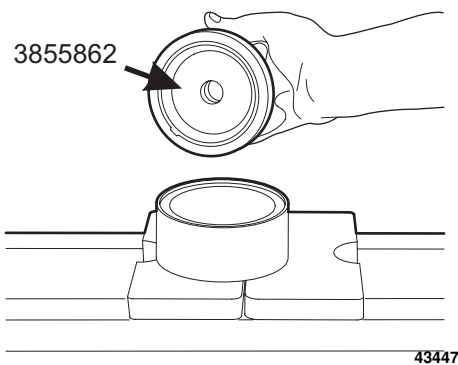
2. Place the assembled tools into the gearcase. Push the remover into the forward bearing race until the snap ring locks into place behind the race. Lightly oil the threads of the rod. Tighten the nut to remove the race. Discard the shims as they may be damaged during race removal.

Propeller Shaft Housing Service

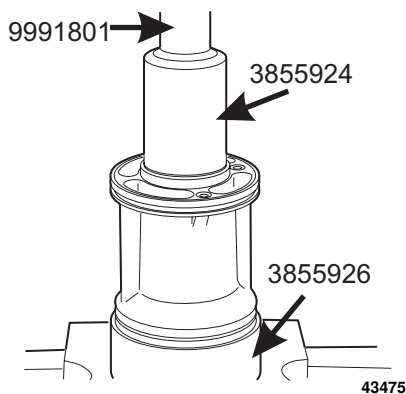
Removal **Note!** Bearings should not be removed unless they are to be replaced. Removal will damage the bearings.



1. Place Support Base, *Volvo Penta* P/N 3855926 notch side up, in a press. Position the housing on the base. Place Seal and Bearing Remover, *Volvo Penta* P/N 3855924 with Standard Shaft, *Volvo Penta* P/N 9991801 into the propeller shaft housing. Press out and discard the bearing and seals.

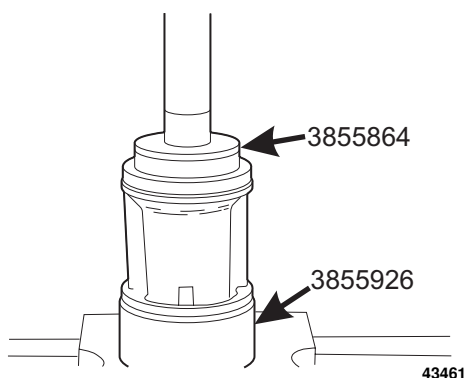


2. Push Race Remover, *Volvo Penta* P/N 3855862 until it snaps into position behind the bearing race.

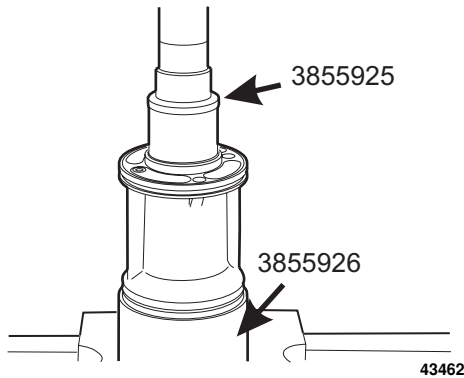


3. Position the housing onto the base. Use Puller, *Volvo Penta* P/N 884789 to press the race out of the housing.

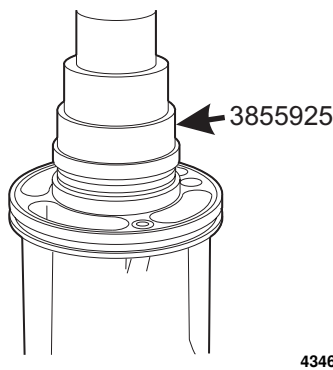
Installation



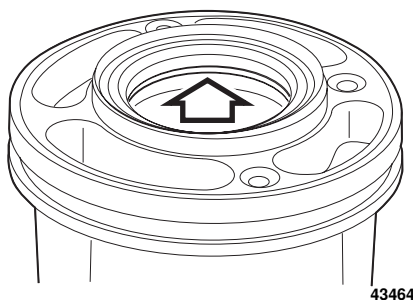
1. Place Support Base, *Volvo Penta* 3855926, notch side up, in a press. Position the housing on the support. Apply a light coating of *GL-5 Synthetic gear lubricant SAE 75W-90* to the outside surface of the bearing race. Position the race into the propeller shaft housing. Press the race squarely into the housing until it seats, using Race Installer, *Volvo Penta* P/N 3855864.



2. Turn the housing over and set it on the support base. Apply a light coating of *GL-5 Synthetic gear lubricant SAE 75W-90* to the outside surface of the bearing. Place the bearing into the housing, numbered side facing up. Use the large diameter end of Seal and Race Installer, *Volvo Penta P/N 3855925-8* to install the bearing. Press the bearing squarely into the housing until the tool seats.



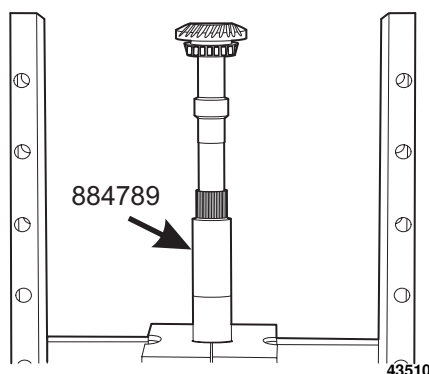
3. Place two seals back to back (seal lips facing away from each other) onto Seal and Race Installer, *Volvo Penta P/N 3855925*, or Joint Venture P/N 3855925. Coat the outside surface of the seals with *Volvo Penta Gasket Sealing Compound*. Press the seals into the housing until the tool seats.



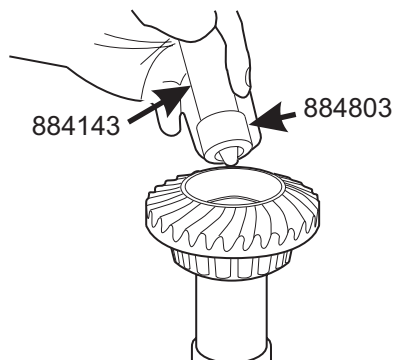
4. Remove the tool and apply a light coat of *Volvo Penta Grease P/N 828250* to the seal lips.

Outer Propeller Shaft Service

Removal **Note!** Bearings should not be removed unless they are to be replaced. Removal will damage the bearings.

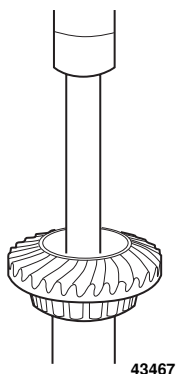


1. Screw Puller, *Volvo Penta P/N 884789* on to the end of the outer propeller shaft to protect the threads. Place the assembly in a press



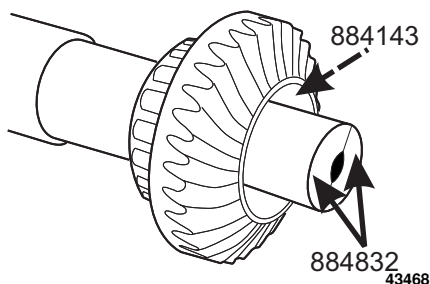
43466

2. Slide Dismantling Tool, *Volvo Penta* P/N 884803, and Drift, *Volvo Penta* P/N 884143 down into the outer propeller shaft.



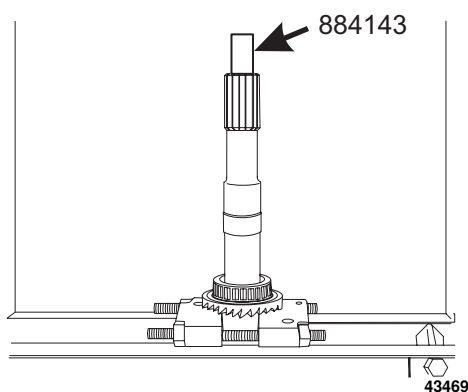
43467

3. Press the bearing and seals out of the outer propeller shaft. Discard the bearing and seals.



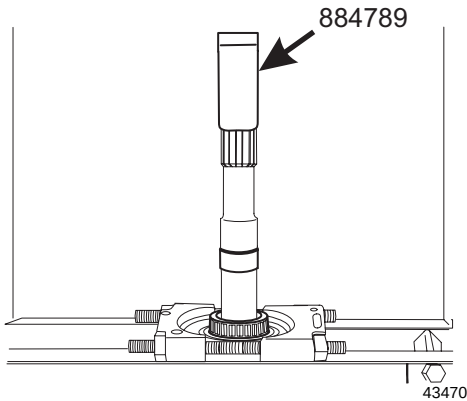
43468

4. Position both parts of Puller, *Volvo Penta* P/N 884832 so the flanges of the puller catch the inside lip of the outer propeller shaft bearing race.



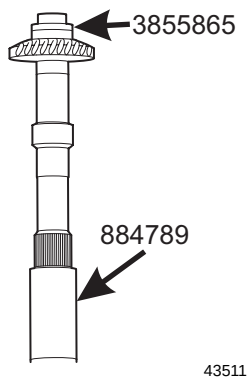
43469

5. Place Drift, *Volvo Penta* P/N 884143 into position through the outer propeller shaft. Support the assembly in a press and remove the race.

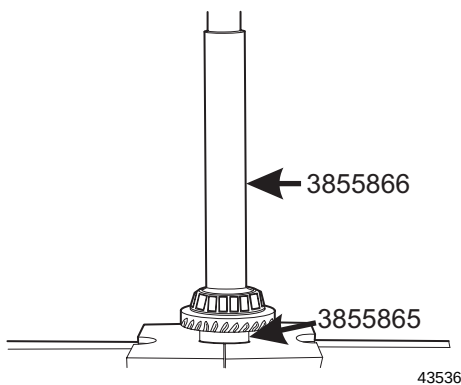


6. Clamp a bearing separator into position to catch the tapered roller bearing. Thread Puller, *Volvo Penta* P/N 884789 onto the outer propeller shaft to protect the threads. Position the outer propeller shaft in a press and remove the bearing and sleeve. **NOTE:** The sleeve may require heat to break the adhesive loose.

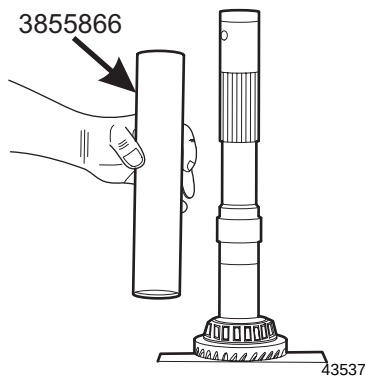
Installation



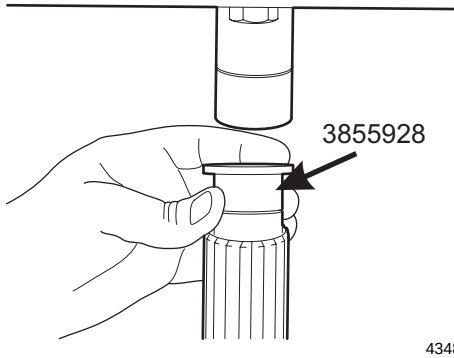
1. Screw Puller, *Volvo Penta* P/N 884789 onto the outer propeller shaft to protect the threads, and position in a press. Apply a light coat of *GL-5 Synthetic gear lubricant SAE 75W-90* to the bearing race. Press the race into the gear using Race Installer, *Volvo Penta* P/N 3855865.



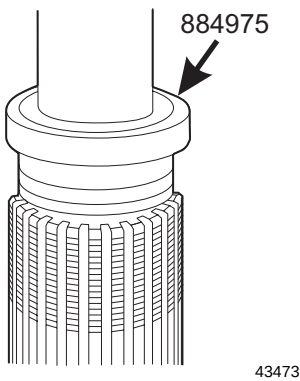
2. Place the outer propeller shaft in a press supported by Race Installer, *Volvo Penta* P/N 3855865. Lightly oil the inside surface of the tapered roller bearing with *GL-5 Synthetic gear lubricant SAE 75W-90* and place it on the outer propeller shaft, tapered side up. Press the bearing into place using Bearing and Sleeve Installer, *Volvo Penta* P/N 3855866.



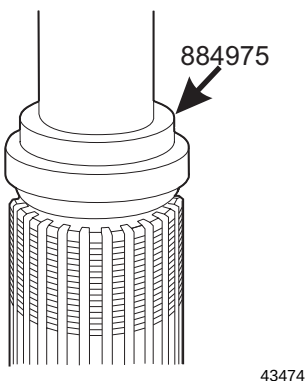
3. Apply *Loctite* Primer to the inside of the sleeve and it's position on the outer propeller shaft and allow to air dry. Apply a small amount of *Loctite 609* to the outer propeller shaft. Position the sleeve on the outer propeller shaft and press into position using Bearing and Sleeve Installer, *Volvo Penta* P/N 3855866.



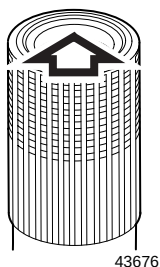
4. Apply a light coating of *GL-5 Synthetic gear lubricant SAE 75W-90* to the outside surface of the needle bearing and position it in the end of the outer propeller shaft. Press the bearing into position until the tool seats using Bearing Installer, *Volvo Penta* P/N 3855928.



5. Place the double lipped seal onto Installation Tool, *Volvo Penta* P/N 884975 with the rubber case facing the stepped side of the installer. Apply a light coat of *Volvo Penta Gasket Sealing Compound* to the outside surface of the seal. Press the seal into place until the tool seats.



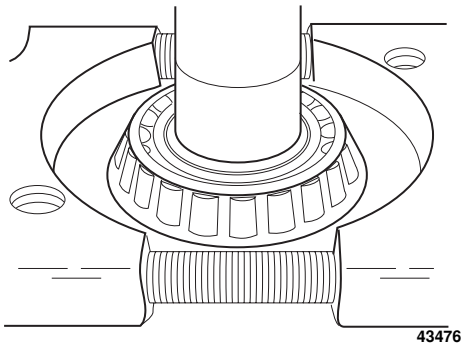
6. Position the single lipped seal onto Installation Tool, *Volvo Penta* P/N 884975 with the open side of the seal facing the installer. Apply a light coat of *Volvo Penta Gasket Sealing Compound* to the outside surface of the seal. Press the seal into place until the tool seats.



7. Remove the tool and apply a light coating of *Volvo Penta Grease* P/N 828250 to the seal lips.

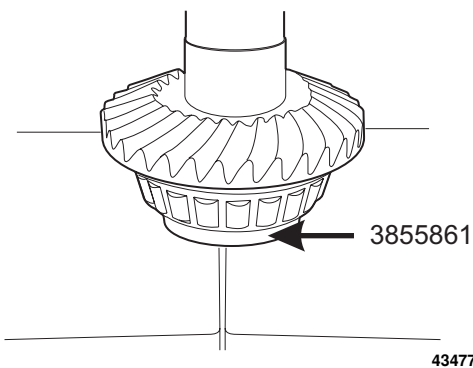
Forward Gear Service

Removal **Note!** **Bearing should not be removed unless it is to be replaced. Removal will damage the bearing.**



Clamp a bearing separator onto the forward gear bearing. Place the assembly in a press and remove the bearing.

Installation



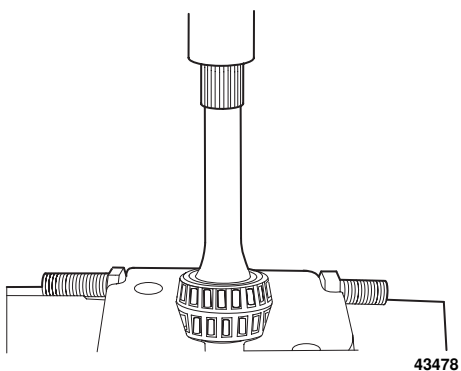
Position Bearing Installer, Volvo Penta P/N 3855861 in a press with the recessed side up. Place the bearing on top of the installer. Apply a light coat of *GL-5 Synthetic gear lubricant SAE 75W-90* to the inside surface of the bearing. Press the gear into position until it seats.

Driveshaft Service

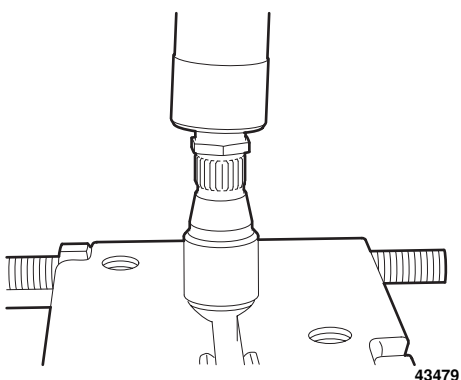
Removal

NOTE! Bearings should not be removed unless they are to be replaced. Removal will damage the bearings.

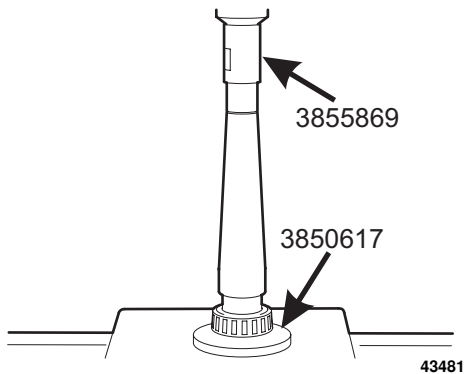
1. Note size, position, and direction of taper of the driveshaft bearings for installation. Using a bearing separator and a press, remove both bearings.



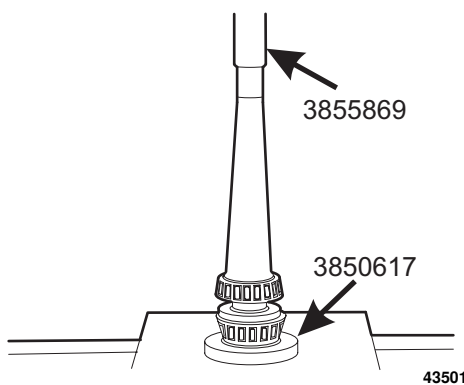
2. Clamp a bearing separator onto the driveshaft so it will catch the sleeve and place in a press. Thread an old pinion nut onto the driveshaft to protect the threads and press the sleeve from the driveshaft. **NOTE:** The sleeve may require heat to break the adhesive loose.



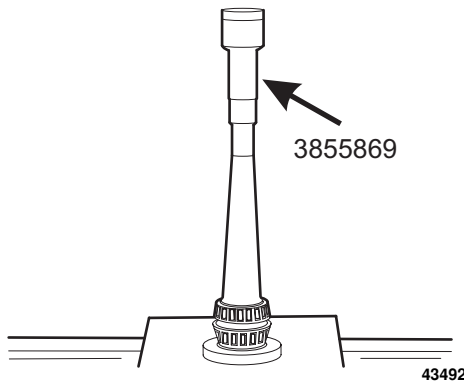
Installation



1. Apply a light coat of *GL-5 Synthetic gear lubricant SAE 75W-90* to the I.D. of the small bearing. Protect threads of driveshaft by placing Sleeve Installer, *Volvo Penta P/N 3855869* onto driveshaft. Slide bearing onto driveshaft with taper facing pinion end. Rest Bearing Installer, *Volvo Penta P/N 3850617* on open jaws of a press support. Position raised lip of Installer up; it must contact backside of bearing. Insert driveshaft into Installer, and press driveshaft into bearing until it seats.



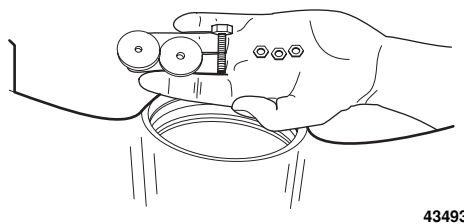
2. Apply a light coat of *GL-5 Synthetic gear lubricant SAE 75W-90* to the I.D. of the large bearing. Protect threads of driveshaft by placing Sleeve Installer, *Volvo Penta P/N 3855869-8* onto driveshaft. Slide bearing onto driveshaft with taper facing away from small bearing. Rest Bearing Installer, *Volvo Penta P/N 3850617* on open jaws of a press support. Position raised lip of Installer up; it must contact nose of bearing. Insert driveshaft into Installer, and press driveshaft into bearing until it seats.



3. Apply *Loctite Primer* to the inside of the sleeve and it's position on the driveshaft and allow to air dry. Apply a small amount of *Loctite 609* to the driveshaft. Position the sleeve on the driveshaft and press into position using Sleeve Installer, *Volvo Penta P/N 3855869*.

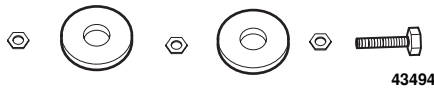
Magnet Service

Removal



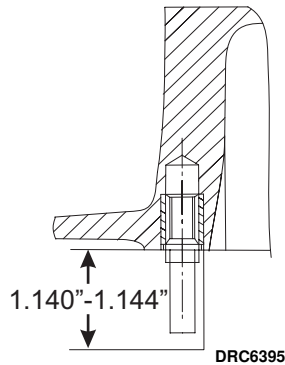
Remove the screw retaining the two magnets and three spring washers from inside of the front of the gearcase. Remove any metal chips from the magnets.

Installation



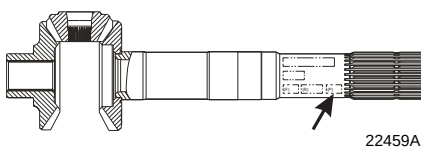
Apply *Loctite* Primer to the retaining screw and let air dry. Apply *Loctite* 242 to the screw threads. Arrange the washers and magnets as shown and install them in the gearcase. Secure with the retaining screw. Tighten the screw securely.

Upper Housing Stud Replacement



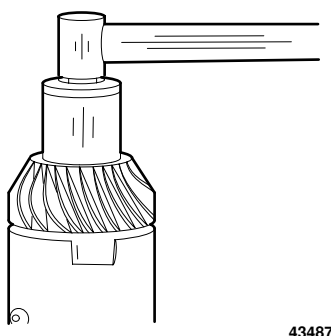
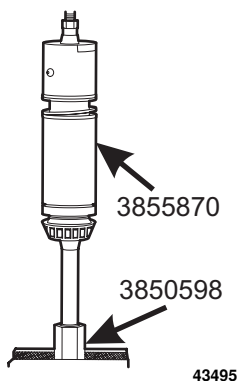
1. Remove the stud to be replaced.
2. Apply *Loctite* Primer to the threads on the short end of the stud and let air dry. Apply *Loctite* 242 to the threads. Screw the stud into the housing until 1.140-1.144 in. (28,95-29,05 mm) remains exposed.

Pinion Shimming



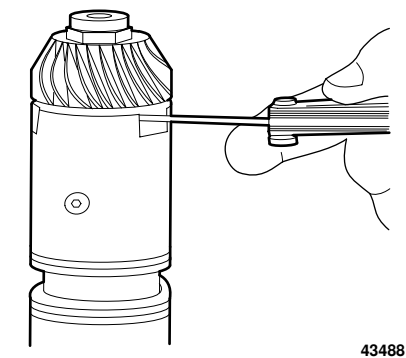
Note! This procedure determines the amount of shims required to properly position the pinion in relation to the forward and outer propeller shafts. Record the following shimming measurement for the final gear lash check.

1. On later models, the gear markings are on the outer propeller shaft. The pinion gear marking will be found in the box with (P) indicating the pinion gear etching.
1. Clamp Spline Socket, *Volvo Penta* P/N 3850598 into a vice and slide driveshaft into socket. Install small bearing cup onto bearing. Slide Shim Fixture, *Volvo Penta* P/N 3855870 onto driveshaft with the three slots facing threaded end of driveshaft.



2. Install pinion and pinion nut. Tighten pinion nut to 72-87 ft. lb. (98-118 N.m). Rotate shim fixture to seat bearing for shimming purposes.

Note! Record this figure for use during reassembly. Failure to reset the pinion torque during reassembly will change gear pattern and lash.



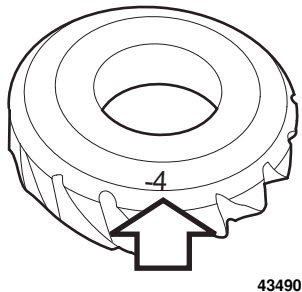
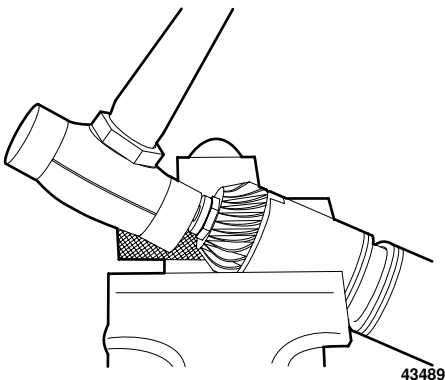
3. Check all three slots with feeler gauge and record each reading. Average the three recorded feeler gauge readings by adding them together, then dividing by three.

Example:

Table 2:

Add:	Divide:
Slot no. 1 = 0.017 in.	0.052 in. ÷ 3 = 0.0173 in.
Slot no. 2 = 0.018 in.	(Round off to 0.017 in.)
Slot no. 3 = 0.017 in.	
Total 0.052 in.	

4. Loosen the pinion nut several turns. Do not remove the nut. Clamp the upper portion of the shim fixture in a vice. Strike the nut and shaft with a mallet to loosen the pinion from the shaft. Remove and discard the nut.



5. Add or subtract the shimming allowance number etched on the gear from the number found in Step 3. If the number is etched **+5**, you would **ADD 0.005 in.** to the number. If the etched number is **-5**, you would **SUBTRACT 0.005 in.** from the number. If the number is zero (0), you would add or subtract nothing from the number.

Example:

Add/Subtract:

0.017 in. figure from Step 3

0.004 in. etched number (-4) on gear

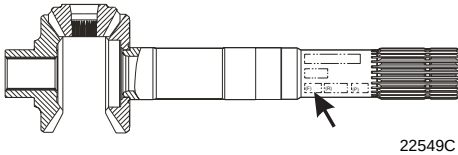
0.013 in. shims required

6. Record dimension (example: 0.013 in.) for the shims required to set pinion position.

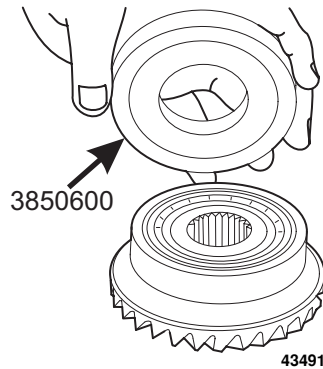
Note! No less than one shim but no more than five shims should be used to obtain the average required shim thickness.

Forward Gear Shimming

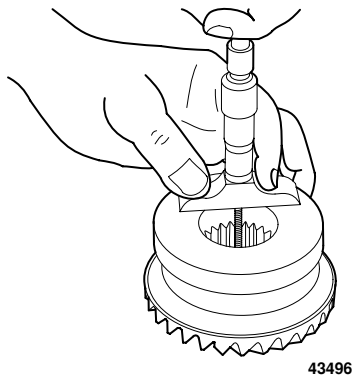
Note! This procedure determines the amount of shims required to properly position the forward gear in relation to the pinion. Record the following shimming measurement for the final gear lash check.



1. On later models, the gear markings are on the outer propeller shaft. The front gear marking will be found in the box with (F) indicating the front gear etching.



2. Place gear and bearing on a flat surface. Place the bearing race on top of the bearing. Rotate the race to seat the bearing. Position Shim Fixture, *Volvo Penta* P/N 3850600-2 on top of the gear and bearing assembly, recessed side facing down.



3. Using a depth micrometer, measure the distance from the top of the shim fixture to the end of the gear shaft in three spots. Average the three recorded measurements by adding them together, then dividing by three. Subtract 0.500 in. from the average measurement.

Example:

Table 3:

Add:	Divide:
No. 1 = 0.546 in.	1.639 in. ÷ 3 = 0.5463 in.
No. 2 = 0.547 in.	(Round off to 0.546 in.)
No. 3 = 0.546 in.	
Total 1.639 in.	

Subtract:

0.546 in. measurement to end of gear shaft

0.500 in. thickness of shim fixture

0.046 in. actual dimension

4. Add or subtract the shimming allowance number etched on the gear from the actual dimension in Step 2. If the etched number is **+5**, you would **ADD 0.005 in.** from the actual dimension in Step 2. If the etched number is **-5**, you would **SUBTRACT 0.005 in.** to the actual dimension in Step 2. If the etched number is zero (0), you add or subtract nothing from the actual dimension in Step 2.

Example:

Add/Subtract:

0.046 in. actual dimension in Step 2

0.000 in. etched number (0) on gear

0.046 in. total

5. Subtract the total figure in Step 3 from a nominal dimension of 0.055 in. This new total is the number of shims required to position the forward gear.

Example:

Subtract:

0.055 in. nominal dimension

0.046 in. total from Step 3

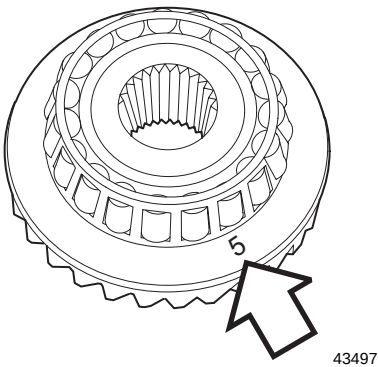
0.009 in. total shims required

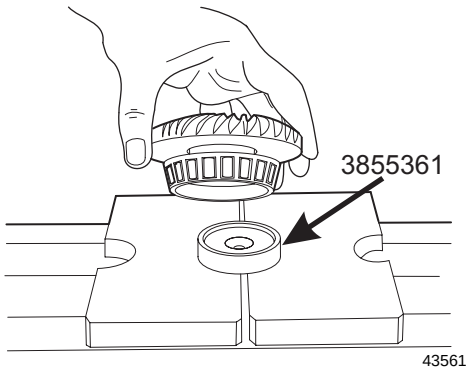
6. Record dimension (example: 0.009 in.) for the forward gear shims required.

Note! No less than one shim but no more than three shims should be used to obtain the required shim thickness.

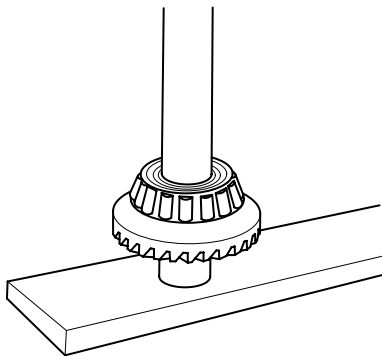
Outer Propeller Shaft Shimming

Note! This procedure determines the amount of shims required to properly position the outer propeller shaft in relation to the pinion. Record the following shimming measurement for the final gear lash check.

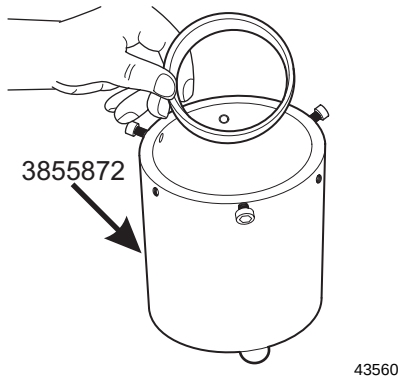




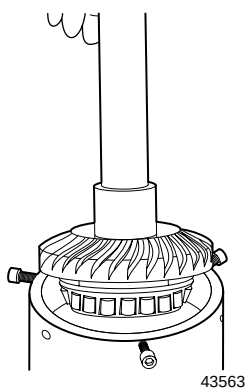
1. Place Bearing Installer, *Volvo Penta* P/N 3855361 in a press with the recessed side of the tool facing up. Center the forward gear on top of the tool



2. Lightly lubricate the splined end of the inner drive shaft with *GL-5 Synthetic gear lubricant SAE 75W-90*. Position the shaft in the forward gear. Thread a rear propeller nut onto the threaded end of the shaft to protect the threads. Press the shaft into place until it seats.

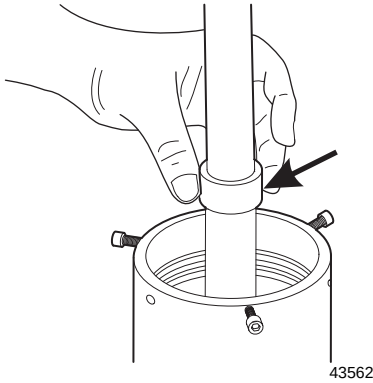


3. Position Shim Fixture, *Volvo Penta* P/N 3855872 on a flat surface. Place the forward gear bearing race (tapered side up) inside the fixture and rest on the three feet.

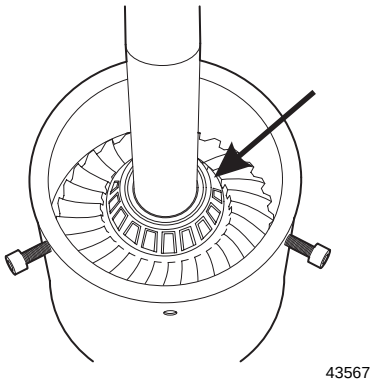


4. Place the forward gear assembly inside the fixture and rest it on the bearing race.

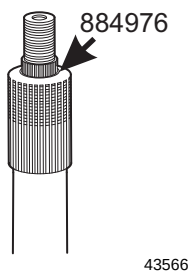
5. Slide Shim Fixture, *Volvo Penta* P/N 3855871 down the inner driveshaft and seat it on the bearing flange.



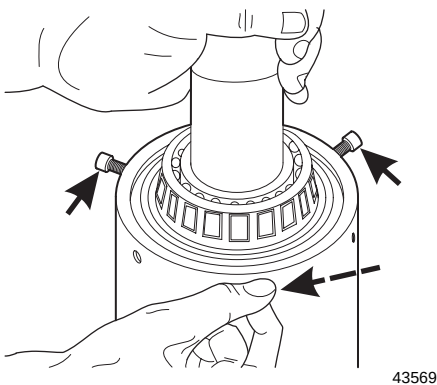
6. Slide the outer gear bearing onto the inner prop shaft and seat it on the shim fixture.

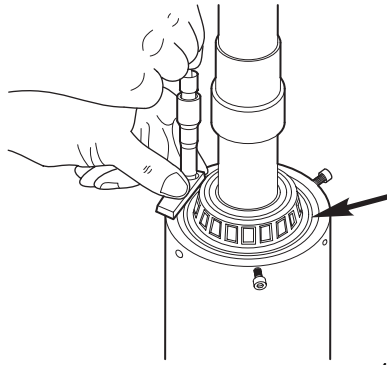


7. Place Protection Sleeve, *Volvo Penta* P/N 884976 over the outer propeller shaft seals. Place the outer propeller shaft onto the inner prop shaft and position it into the shim fixture. Remove the seal protector.



8. Spin both shafts to seat the gears. Load the assembly by pressing down on the outer propeller shaft. Finger tighten the three set screws to stabilize the outer propeller shaft.





43531

9. Position a depth micrometer to take a measurement from the top of the shim fixture to the machined ring on the outer propeller shaft. Take a measurement by each of the three set screws. Average the measurements by adding them together and dividing by three.

Example:

Table 4:

Add:	Divide:
No. 1 = 0.039 in.	$0.121 \text{ in.} \div 3 = 0.0403 \text{ in.}$
No. 2 = 0.043 in.	(Round off to 0.040 in.)
No. 3 = 0.039 in.	
Total 0.121 in.	

10. Subtract the amount of shims required to position the forward gear from the average depth measurement from Step 9.

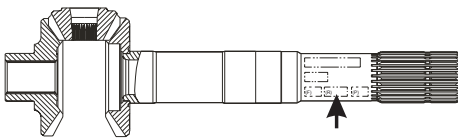
Example:

Subtract:

0.040 in. average depth from Step 9

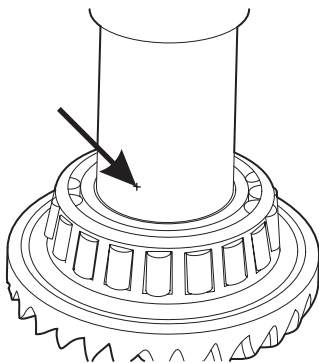
0.009 in. forward gear shims

0.031 in. total



22459B

11. On later models, the gear markings are on the outer propeller shaft. The Rear gear marking will be found in the box with (R) indicating the Rear gear etching.



43578

12. Add or subtract the shimming allowance number etched on the gear from the actual dimension in Step 10. If the etched number is **+5**, you would **ADD 0.005 in.** from the actual dimension in Step 10. If the etched number is **-5**, you would **SUBTRACT 0.005 in.** to the actual dimension in Step 10. If the etched number is zero (0), you add or subtract nothing from the actual dimension in Step 10.

Example:

Add/Subtract:

0.031 in. actual dimension in Step 10

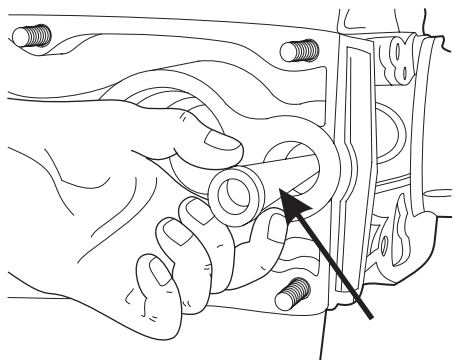
0.002 in. etched number (+2) on gear

0.033 in. total shims required

13. Record dimension (example: 0.033 in.) for the outer propeller shaft shims required.

Note! Use the least number of shims possible to obtain the required shim thickness.

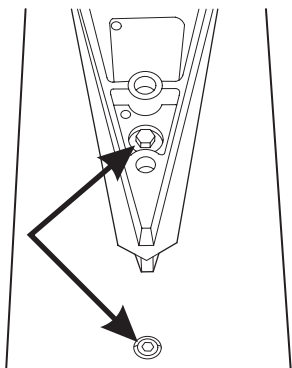
Oil Screen Service - Upper Housing



43675

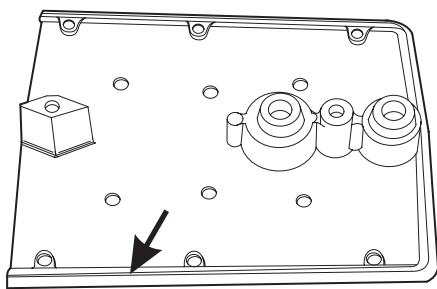
Remove the oil screen from the upper gear housing. Clean and replace as necessary. Install the oil screen into the oil passage in the upper gear housing. Make sure the screen is secure.

Exhaust Cover Service



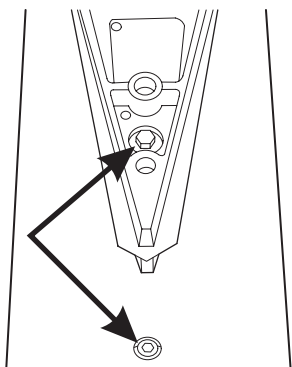
43626

1. Remove two screws and remove exhaust cover. Remove and discard seal.



43628

2. Apply *Loctite* Gasket Adhesive (yellow) to the exhaust cover groove and install a new seal.



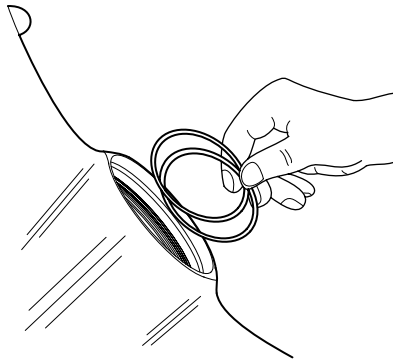
43626

3. Apply *Loctite* Primer to the two screws and let air dry. Apply *Loctite* 242 to the screw threads. Install the cover and secure with two screws. Tighten the screws to 14-17 ft. lb. (19,5-22,5 N.m).

Lower Gearcase Assembly

Gearease Bearing and Race Installation

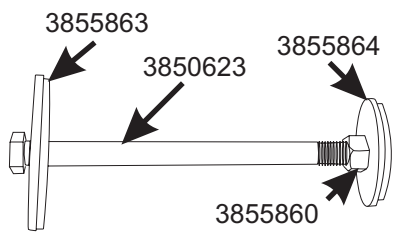
Forward Bearing Race



43532

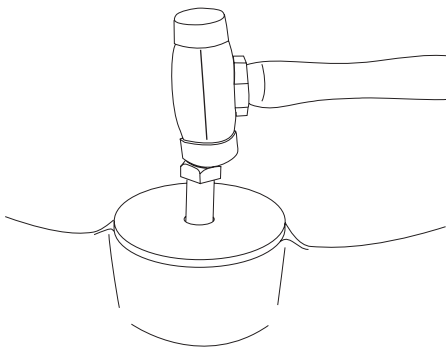
1. Select the correct number of shims to equal your recorded measurement. Place shims into recess of bearing race bore.

Note! No less than one shim but no more than three shims should be used. If possible, sandwich the thinnest shims in between the thickest shims.



43542

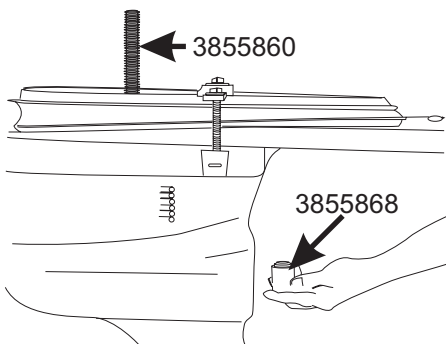
2. Apply a light coat of *GL-5 Synthetic gear lubricant SAE 75W-90* to the bearing race. Place bearing race on top of shims in lower gearcase. Slide Guide Plate, *Volvo Penta P/N 3855863* onto Rod, *Volvo Penta P/N 3850623*. Screw nut from Rod, Nut and Washer, *Volvo Penta P/N 3855860* and Race Installer, *Volvo Penta P/N 3855864* onto rod. Tighten the nut against the installer.



43544

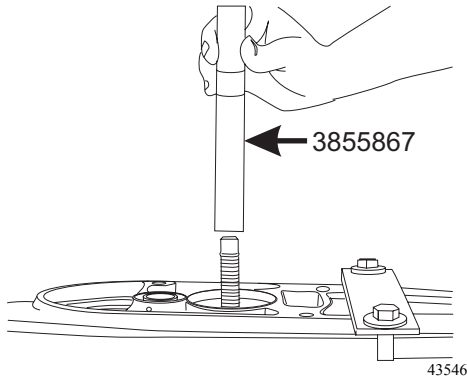
3. Use a wooden 2x4 or 2x6 to cushion forward gearcase edge. **Wear Safety Glasses.** Drive bearing cup in until seated.

Pinion Bearing

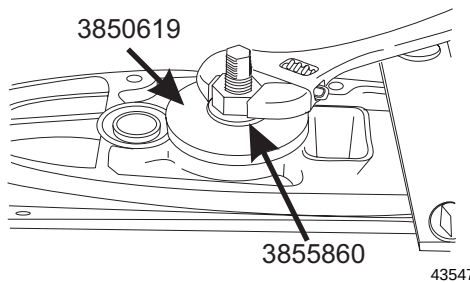


43545

1. Lightly oil the outside case of the pinion bearing with *GL-5 Synthetic gear lubricant SAE 75W-90* gear lubricant and place it on Remover and Installer, *Volvo Penta P/N 3855868* with the numbers facing the installer. Position the bearing and installer inside the gearcase. Thread the rod from Rod, Nut and Washer, *Volvo Penta P/N 3855860*, into the installer.

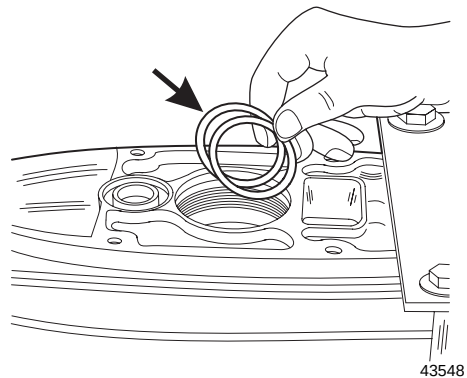


2. Place Spacer, *Volvo Penta* P/N 3855867 onto the rod. Lightly oil the rod with gear oil.



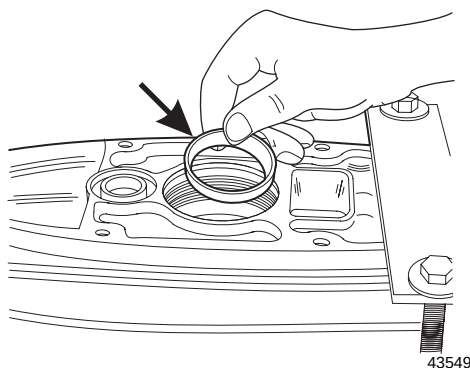
3. Place Guide Plate, *Volvo Penta* P/N 3850619 and washer and nut from Rod, Nut and Washer, *Volvo Penta* P/N 3855860 onto the rod. Tighten the nut to pull the bearing into place until the tool seats.

Lower Driveshaft Bearing

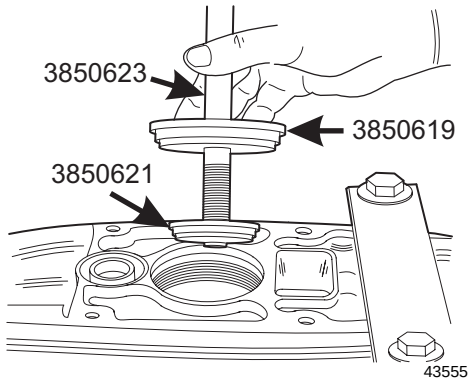


1. Select the correct number of shims to equal your recorded measurement. Place shims into recess of bearing race bore.

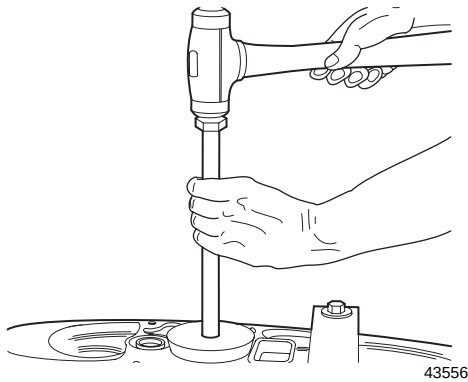
Note! No less than one shim but no more than five shims should be used. If possible, sandwich the thinnest shims in between the thickest shims.



2. Apply a light coat of *Volvo Penta GL-5 Synthetic gear lubricant* SAE 75W-90 to the bearing race. Place bearing race on top of shims in lower gearcase.

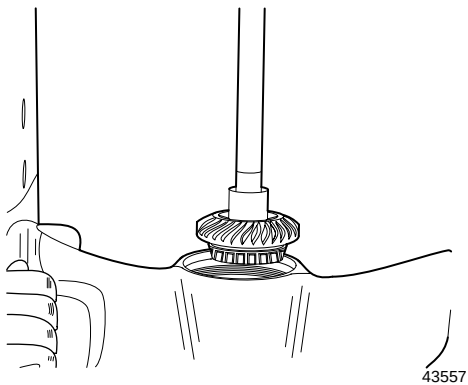


3. Use Rod, *Volvo Penta* P/N 3850623, Guide Plate *Volvo Penta* P/N 3850619, and Bearing Cup Installer, *Volvo Penta* P/N 3850621-8, to install bearing race. Place race installer on race, then seat guide plate onto gearcase.

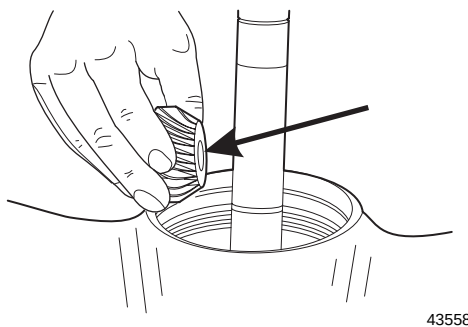


4. **Wear Safety Glasses.** Use a hammer to seat bearing race.

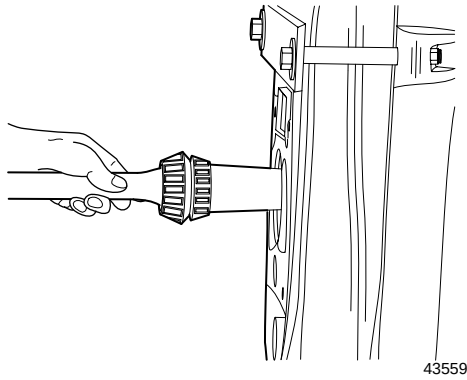
Driveshaft and Pinion Installation



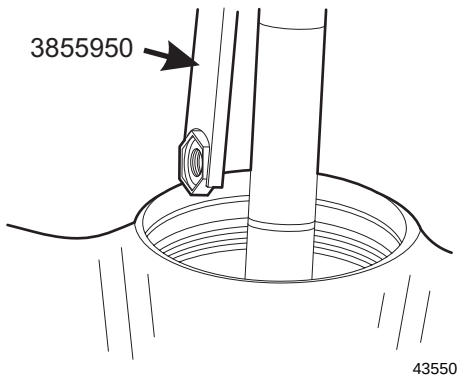
1. Lightly oil the forward gear bearing with *GL-5 Synthetic gear lubricant* SAE 75W-90. Install the assembly into the gearcase.



2. Make sure the pinion taper and splines are clean and dry. Place the pinion into position inside the gearcase.

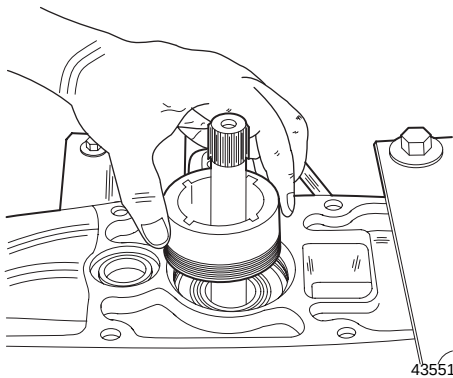


3. Lightly oil all vertical driveshaft bearings with *GL-5 Synthetic gear lubricant SAE 75W- 90*. Make sure the driveshaft pinion taper and splines are clean and dry. Install the driveshaft into the gearcase and engage the pinion.

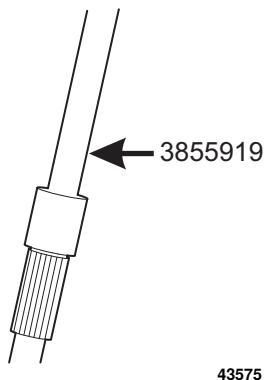


4. Place a new pinion nut into Pinion Nut Holder, *Volvo Penta P/N 3855930*. Position the nut and start to thread it onto the driveshaft. **Do not attempt to tighten the pinion nut with this tool.** The tool will be damaged.

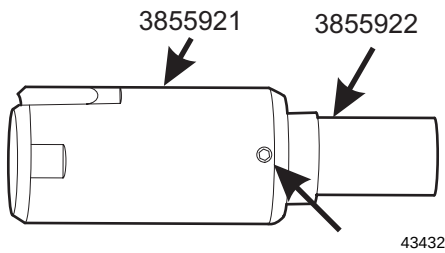
Setting Initial Rolling Torque



1. Apply a light coat of *GL-5 Synthetic gear lubricant SAE 75W-90* to the threads of the driveshaft retainer and upper bearing cup. Place cup in housing, and push down until it seats on driveshaft bearing. Screw in driveshaft retainer by hand to retain upper driveshaft bearing cup.

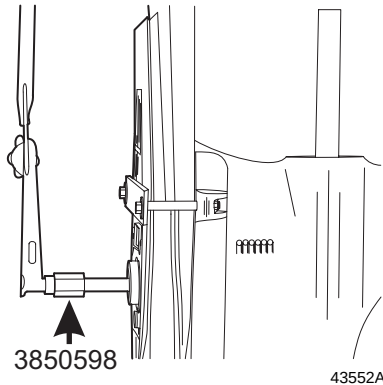


2. Turn the gearcase so the inner propeller shaft is vertical. Thread Propeller Shaft Adaptor, *Volvo Penta P/N 3855919* onto the end of the inner propeller shaft.



3. Assemble Pusher Tip, *Volvo Penta* P/N 3855921 and Tube, *Volvo Penta* P/N 3855922. Tighten set screw securely.
4. Slide the assembled tools over the inner propeller shaft. Align the notch in the end of the pusher tip with the pinion nut. Turn the vertical drive shaft to help the alignment. Thread Nut, *Volvo Penta* P/N 3855920 onto the adaptor and tighten enough to secure the tools to the inner propeller shaft.

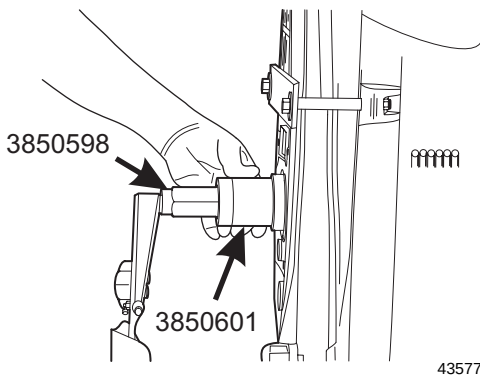
Note! Tightening the nut too much will start to pull the inner propeller shaft out of the forward gear.



5. Place Spline Socket, *Volvo Penta* P/N 3850598 onto the drive-shaft. Tighten the pinion nut to the figure recorded during the shimming procedure.

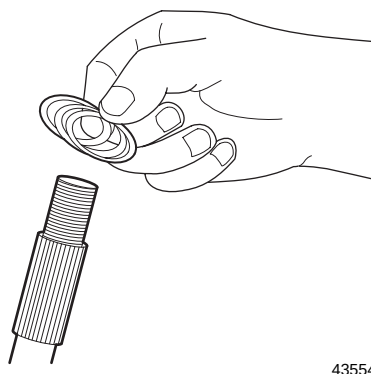
Note! This procedure will ensure bearing life by setting the driveshaft rolling torque. The *inner propeller shaft must be vertical for this procedure*. This will ensure the forward gear and inner propeller shaft will not interfere with the pinion rolling torque measurement. *Record the following measurement for the final rolling torque setting.*

6. Turn driveshaft several times to ensure bearings are seated before each torque reading.



7. Place Spline Socket, *Volvo Penta* P/N 3850598 onto the drive-shaft. Tighten driveshaft retainer, using Spanner, *Volvo Penta* P/N 3850601 to achieve a driveshaft rolling torque of 2-4 in. lb. (0,22-0,45 N.m). **Record rolling torque setting.**

Propeller Shaft Housing and Propeller Shaft Installation

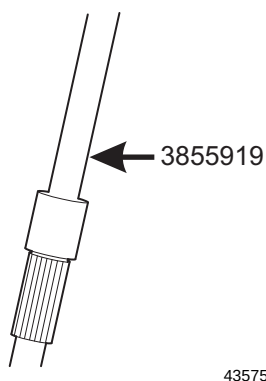


1. Select the correct number of shims to equal your recorded measurement. Place shims onto the inner propeller shaft and slide them into position.

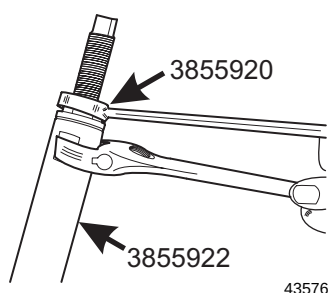
Note! Use the least number of shims possible and sandwich the thinnest shims in between the thickest shims.



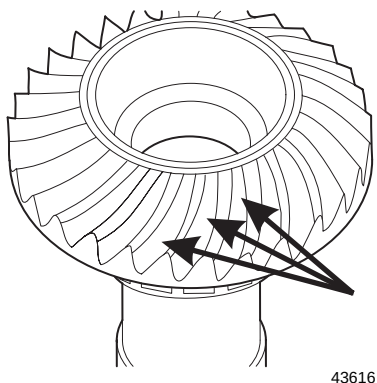
2. Apply a light coat of *GL-5 Synthetic gear lubricant SAE 75W-90* to the outer gear bearing and slide it down into position inside the gearcase.



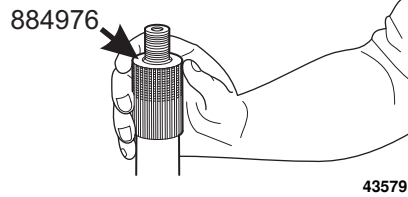
3. Thread the Propeller Shaft Adaptor, *Volvo Penta P/N 3855919* onto the inner propeller shaft.



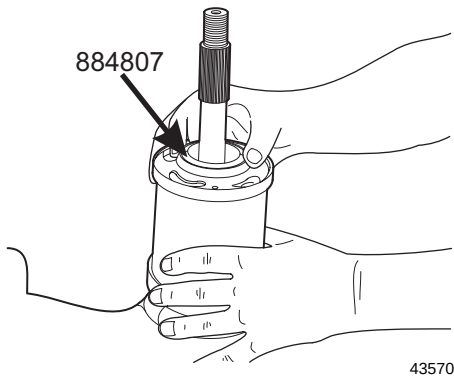
4. Slide Tube, *Volvo Penta P/N 3855922* over the inner propeller shaft and rest it on the outer gear bearing. Apply *Volvo Penta Grease P/N 828250* to the end of the tube. Thread Nut, *Volvo Penta P/N 3855920* onto the adaptor. Tighten the nut to install the bearing until the bearing seats.



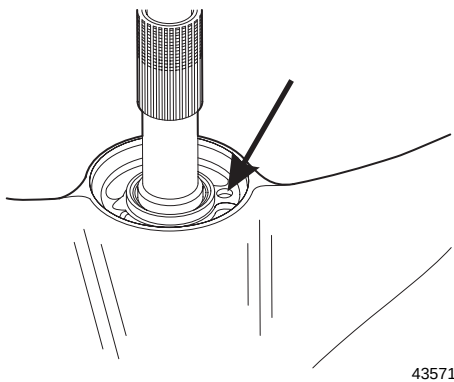
5. Apply gear marking compound such as *GM Gear Marking Compound, P/N 1052351*, to several teeth of outer propeller shaft



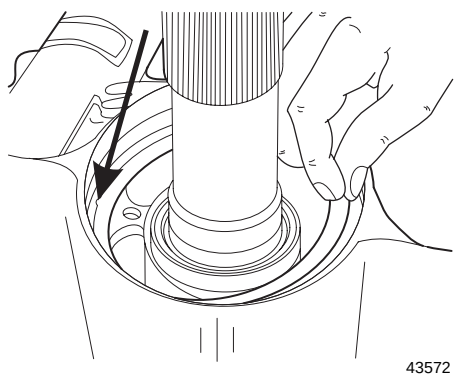
6. Place Protection Sleeve, *Volvo Penta* P/N 884976 into the seals of the outer propeller shaft. Slide the tube gear into place on the inner propeller shaft. Remove the sleeve.



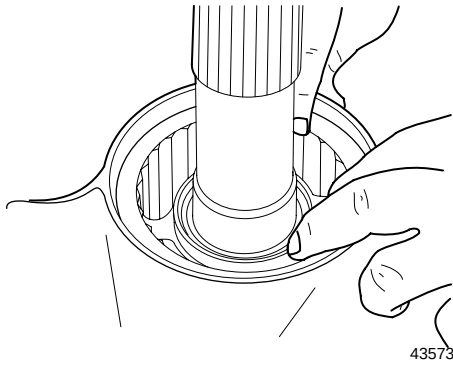
7. Place Protection Sleeve, *Volvo Penta* P/N 884807 into the seals of the propeller shaft housing. Slide the housing into position over the outer propeller shaft with out O-rings. Seat the housing into the gearcase.



8. Make sure the oil drain hole is facing the skeg.

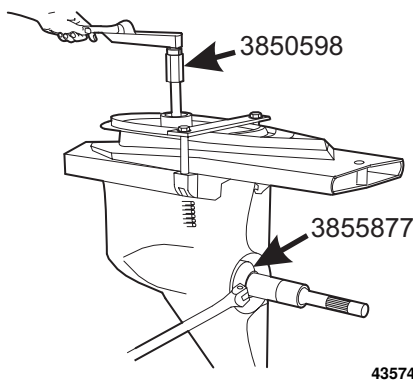


9. Install the bearing housing retainer into position with the tab into the hole in the gearcase.



10. Apply a light coat of *GL-5 Synthetic gear lubricant SAE 75W-90* to the threads of the retaining ring. Thread the retaining ring, without O-rings, into the end of the gearcase.

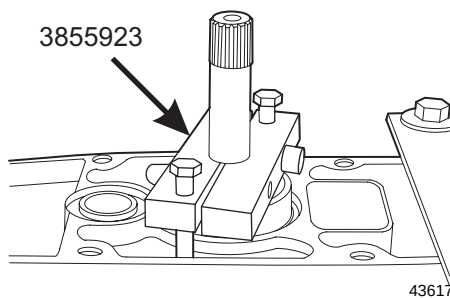
Setting Final Rolling Torque



Use Spanner Tool, *Volvo Penta P/N 3855877* and Spline Socket, *Volvo Penta P/N 3850598* to turn driveshaft and tighten the retaining ring. This will set final rolling torque for the lower gearcase. Set rolling torque at 18-26 in. lb. (2,0-2,9 N.m) for 1.95 and 2.32 gear ratio sterndrives and 26-35 in. lb. (2,9-4,0 N.m) for 1.68 and 1.78 gear ratio sterndrives. Record the rolling torque measurement.

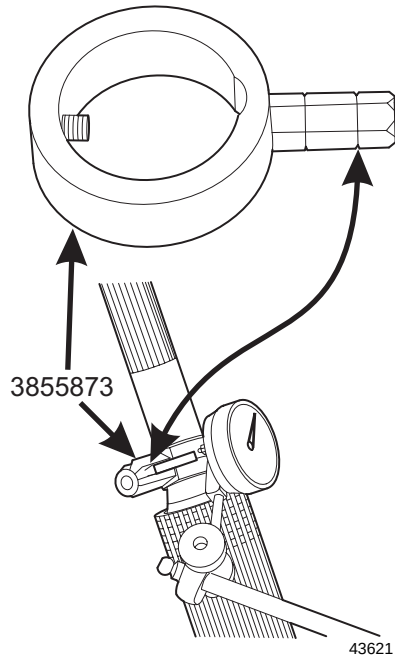
Gear Lash

Note! Verify that there is Zero end play on the vertical driveshaft and both propeller shafts before attempting to check gear lash.

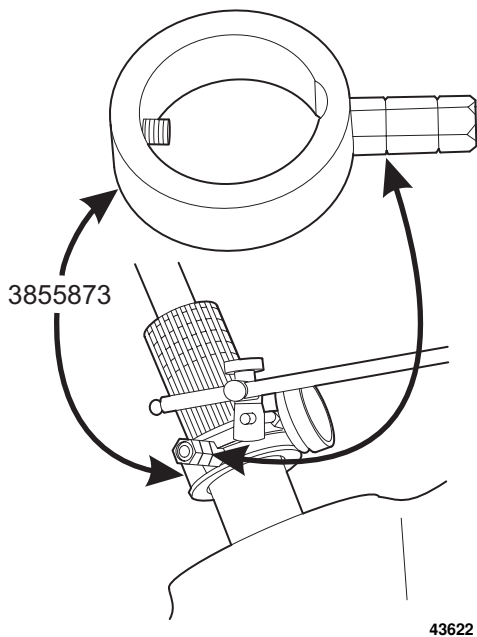


1. Lock the vertical driveshaft in place using Driveshaft Puller, *Volvo Penta P/N 3855923*. Tighten Allen head screws to lock tool to the driveshaft. Lightly tighten screws to keep the driveshaft from moving.

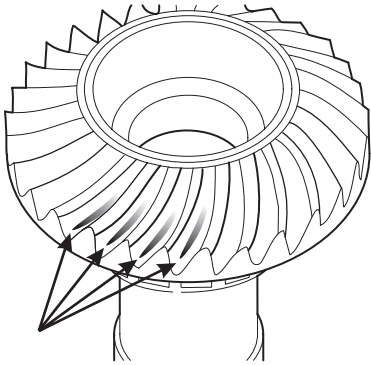
2. Place Lash Tool, *Volvo Penta* P/N 3855873 onto the inner propeller shaft. Stay away from the propeller splines. Set up a dial indicator to read the forward gear lash, by setting the indicator tip on outer lash tool line. Rotate the inner propeller shaft back and forth to check the amount of lash for the forward gear. Lash should be 0.006-0.012 in. (0,15-0,30 mm). Record your measurements.



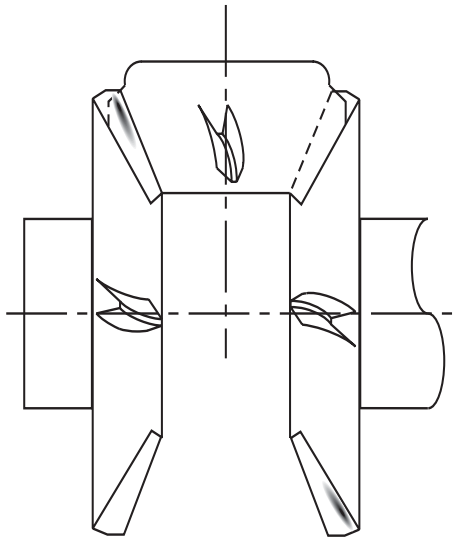
3. Reposition the Lash Tool, *Volvo Penta* P/N 3855873 onto the outer propeller shaft. Stay away from the propeller splines. Set up a dial indicator to read the rear gear lash, by setting the indicator tip on inner lash tool line. Rotate the outer propeller shaft back and forth to check the amount of lash for the rear gear. Lash should be 0.006-0.014 in. (0,15-0,35 mm). Record your measurements.



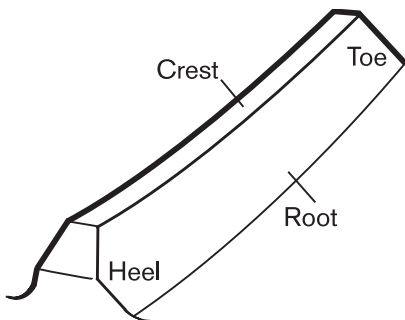
Checking Tooth Contact Pattern



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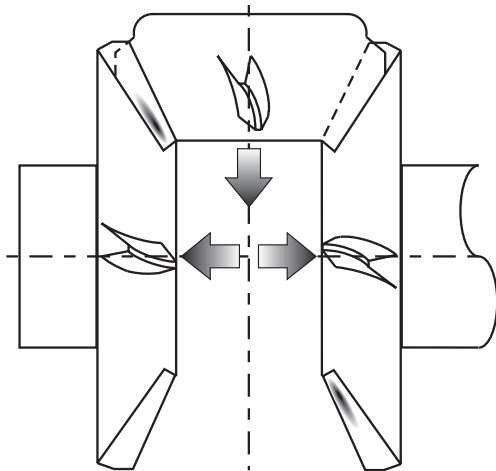


DRC7524

1. Wrap a rag around each propeller shaft. Hold on to the shafts while turning the vertical drive shaft. This will load the gears and give a good tooth contact pattern on the rear gear.
2. Remove the outer propeller shaft and propeller shaft housing following the instructions found elsewhere in this section.
3. Check the tooth contact pattern on the outer propeller shaft. The contact pattern should be located towards the big end with a slight displacement towards the root of the tooth.
4. If the tooth contact pattern and gear lash are within specifications, proceed with the reassembly of the gearcase. If either the pattern or the lash are out of specifications, proceed with **Adjusting Tooth Contact Pattern and Gear Lash**.

Adjusting Tooth Contact Pattern and Gear Lash

Tooth Contact Pattern

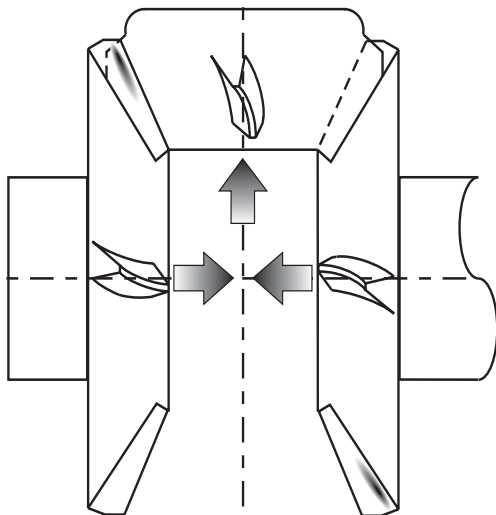


DRC6397

Note! Contact pattern must be corrected before attempting to correct gear lash.

If the contact pattern is too far up towards the top of the tooth and towards the inside of the gear, change the shims as follows:

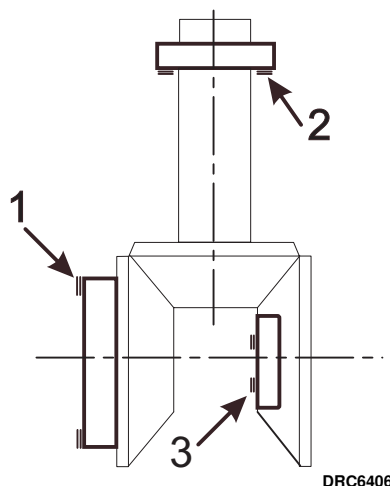
- Subtract shims from position (1)
- Subtract shims from position (2)
- Add shims to position (3)



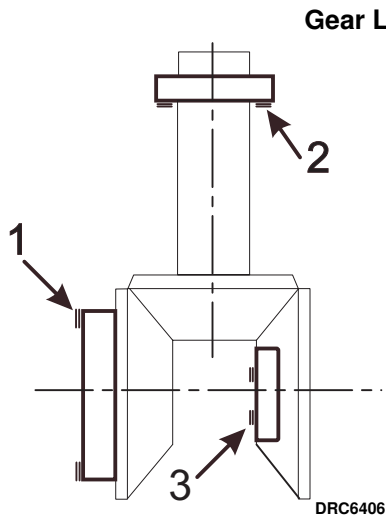
DRC6398

If the contact pattern is too far down at the root of the tooth and towards to outside of the gear, change the shims as follows:

- Add shims to position (1)
- Add shims to position (2)
- Subtract shims from position (3)



DRC6406



Gear Lash

Note! Contact pattern must be correct before attempting to correct gear lash. If the contact pattern on the outer propeller shaft is correct, the outer propeller shaft lash will also be within specifications. Therefore, only forward gear lash will generally need to be corrected.

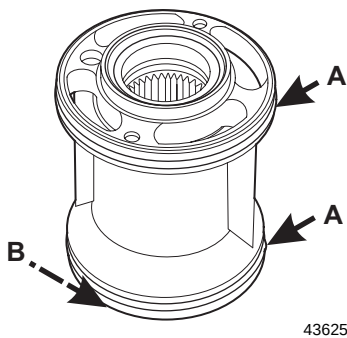
If the forward gear lash must be increased without changing the tooth contact pattern, change the shims equally as follows:

- Subtract shims from position (1)
- Add shims to position (3)

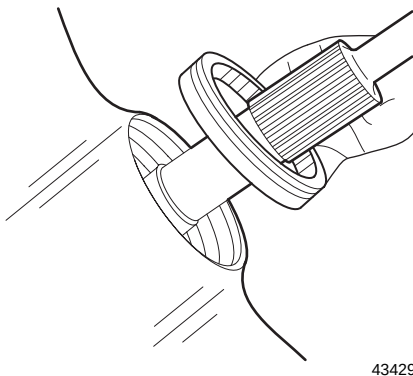
If the forward gear lash must be decreased without changing the tooth contact pattern, change the shims equally as follows:

- Add shims to position (1)
- Subtract shims from position (3)

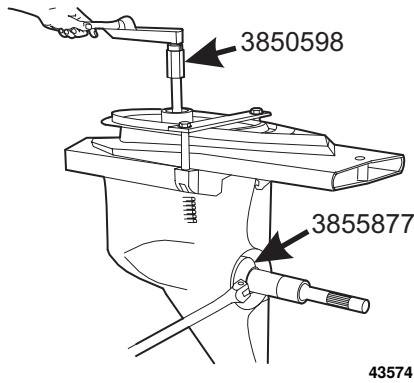
Final Assembly



1. Reinstall the outer propeller shaft See "Propeller Shaft Housing and Propeller Shaft Installation" on page 209.
2. Apply a light coating of *GL-5 Synthetic gear lubricant SAE 75W-90* to the two large (A) and one small O-rings (B). Install them in their grooves. Coat the flange of the propeller shaft housing with gear lube also.
3. Reinstall the propeller shaft housing See "Propeller Shaft Housing and Propeller Shaft Installation" on page 209.
4. Apply a light coating of *GL-5 Synthetic gear lubricant SAE 75W-90* to the large and small O-rings. Install them in their grooves. Also coat the threads of the retaining ring with gear lube.

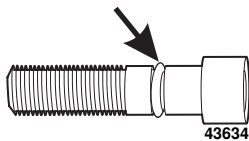


5. Reinstall the retaining ring into the housing.

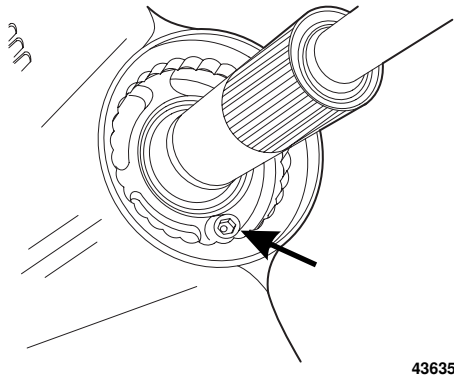


6. Use Spanner Tool, *Volvo Penta* P/N 3855877 and Spline Socket, *Volvo Penta* P/N 3850598 to turn driveshaft and tighten the retaining ring. Reset the rolling torque to the torque established earlier. Adjust the retaining ring to align with the oil drain hole.

Note! Failure to reset the rolling torque to the figure established in an earlier procedure will change gear lash and tooth contact pattern.

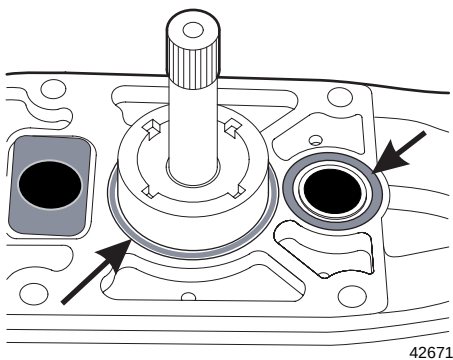


7. Apply a light coat of *GL-5 Synthetic gear lubricant SAE 75W-90* to the drain screw O-ring. Place the O-ring onto the drain screw.



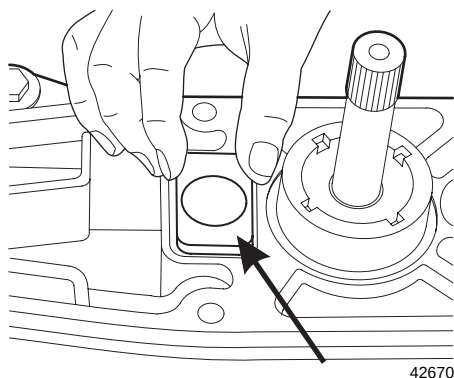
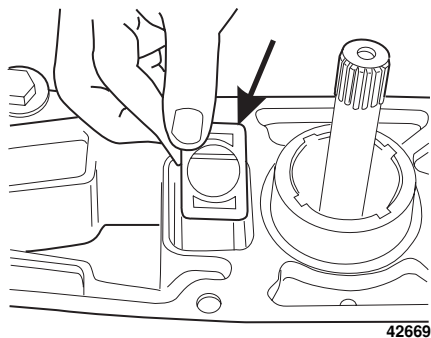
8. Install the drain screw and tighten to 10-15 ft. lb. (14-20 N.m).

Lower Gearcase Installation

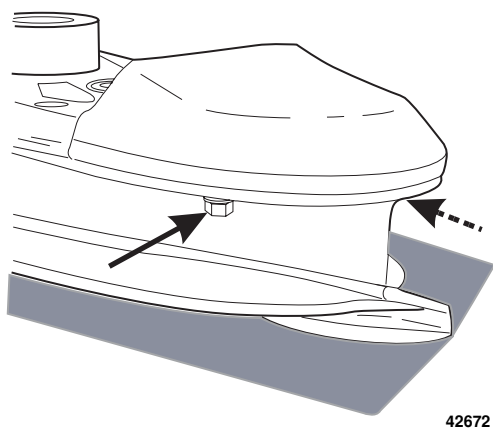


1. Apply *GL-5 Synthetic gear lubricant SAE 75W-90* to a new drive shaft retainer O-ring and new oil passage O-ring. Install the O-rings into their respective grooves.

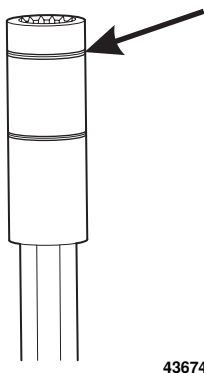
2. Install water tube retainer. Apply *Volvo Penta Gasket Sealing Compound* to the outside of the water tube seal and install in cavity.

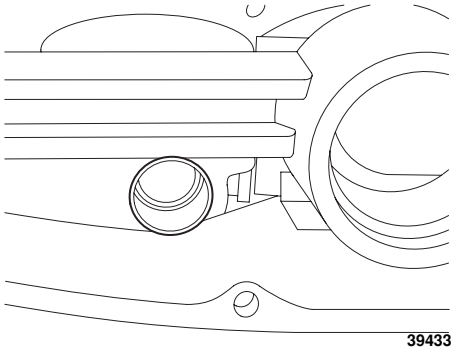


3. Install anode and secure with two screws. Tighten the screws to 60-84 in. lb. (6,8-9,5 N.m).



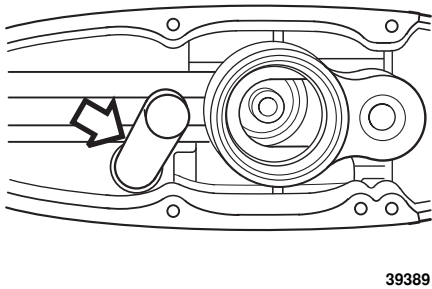
4. Install intermediate driveshaft with the groove facing upward, onto driveshaft.



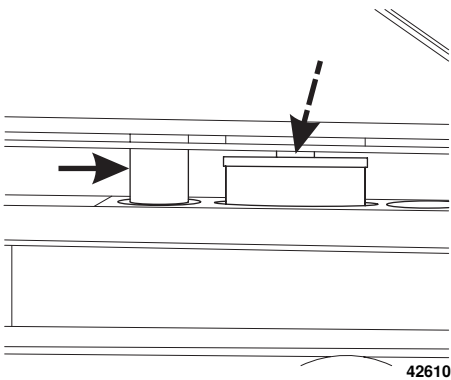


5. Install and position water grommet and supply tube into upper gear housing. Check oil filter for proper installation.

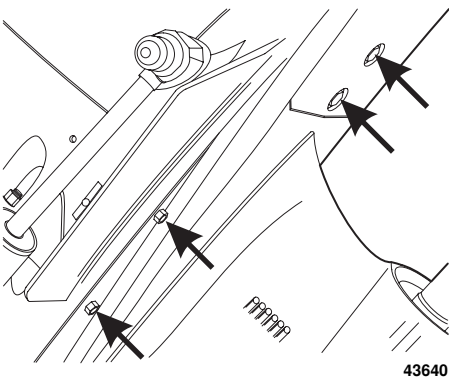
Note! Care must be used on reassembly of gearcase. If machined surface is damaged, leakage may occur.



6. Attach lower gearcase to upper gear housing. Engage intermediate driveshaft splines and water supply tube.



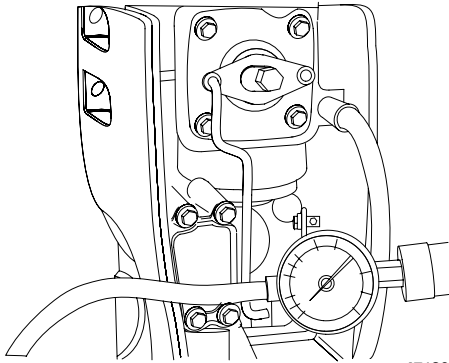
7. Apply *Volvo Penta Gasket Sealing Compound* to the lower gearcase mounting screws and studs. Install four nuts, two on either side of gearcase, and two longer screws aft. Tighten 3/8-16 nuts and screw to 22-24 ft. lb. (30-33 N.m) and 7/16,-14 screw to 32-40 ft. lb. (43-54 N.m).



Pressure and Vacuum Testing

Before filling drive with gearcase oil, it must be pressure and vacuum tested to verify proper sealing during assembly. Remove the oil level plug at the back of the gear housing. Install and tighten oil level dipstick at top of drive and the drain plug at the end of the gearcase.

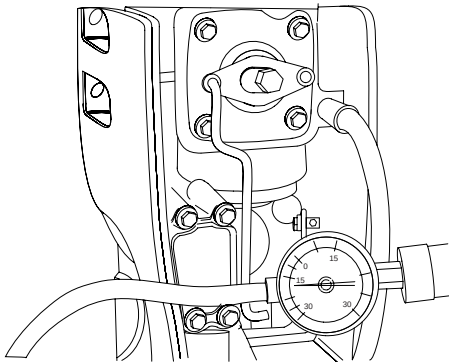
Pressure Testing



47120

1. Attach a pressure tester (such as a Stevens S-34) to the oil level hole, and pressurize drive to 3-5 PSI (20,7-34,5 kPa). Rotate propeller shaft and Universal Joint shaft to check sealing. If pressure loss is indicated, use a soapy water solution or submerge drive in water to find source. Make necessary repairs then repeat test.
2. If pressure loss is not indicated, increase pressure to 16-18 PSI (110-124 kPa). Again, use a soapy water solution or submerge in water to find source if drive loses pressure. Make repairs as necessary and repeat test. Drive must hold pressure before making vacuum test, and must not lose more than 1 PSI (6,9 kPa) in 3 minutes.

Vacuum Testing



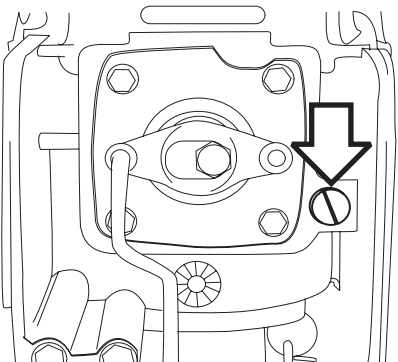
47119

1. Attach a vacuum tester (such as a Stevens V-34) to the oil level hole, and pull vacuum to 3-5 inches of mercury (10-16,8 kPa). Rotate propeller and Universal Joint shaft to check sealing. If drive does not hold vacuum, apply a heavy oil to seal surfaces to find source. Make necessary repairs then repeat test. No loss of vacuum should occur on low test.
2. If vacuum loss is not indicated, increase vacuum to 14-16 inches of mercury (47-54 kPa). Again, apply heavy oil to find source if drive will not hold vacuum. Make repairs as necessary and repeat test. Drive must not lose more than 1 inch of mercury (3,4 kPa) in 3 minutes.

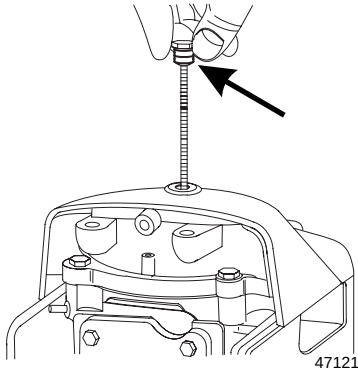
Sterndrive Filling

Note! *Do not fill sterndrive with oil until it passes both pressure and vacuum tests. Drives that fail either test will allow water entry when in use and cause subsequent damage to internal parts.*

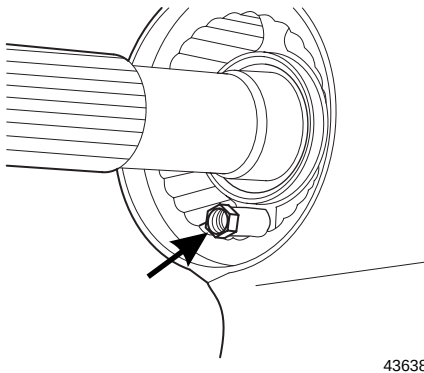
1. Place drive in a vertical position. Remove the rear plastic cover to allow access to the oil level plug if installed.
2. Remove the oil level plug.



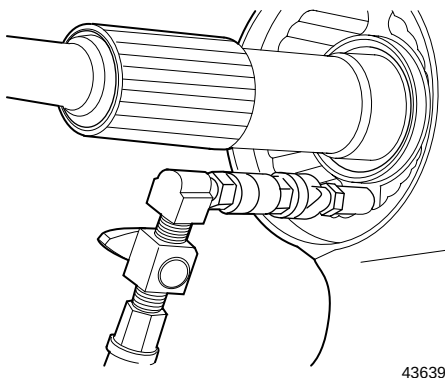
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3. Remove the dipstick at top of drive to help vent the drive. Discard and dipstick O-ring. Replace with new one.



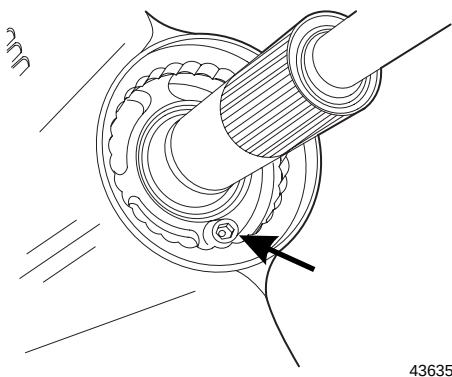
4. Remove drain screw at the back of the gearcase. Discard O-ring and replace with a new one. Install Fill Adaptor, *Volvo Penta* P/N 3855932.



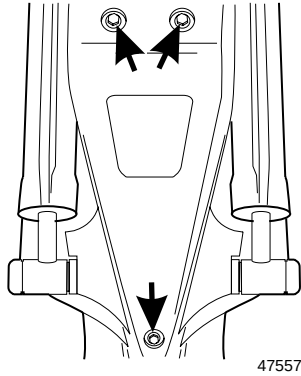
5. Fill drive with *GL-5 Synthetic gear lubricant SAE 75W-90* from drain hole. Fill slowly to purge trapped air. Stop filling when the oil level reaches the bottom of the oil level hole. **Do not overfill.**

Note! Filling drive too quickly may form air pockets that will cause an inaccurate oil level reading. Running drive with improper oil level can result in immediate internal damage.

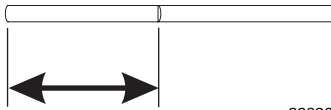
6. When oil reaches proper level, stop filling and screw in the level plug and dipstick. This will create an air lock to prevent excessive oil loss while drain plug is installed.



7. Apply *GL-5 Synthetic gear lubricant SAE 75W-90* to the drain plug O-ring. Install and tighten drain plug to 10-15 ft. lb. (14-20 N.m).
8. Apply *Volvo Penta Gasket Sealing Compound* to the level plug and dipstick. Tighten them to 48-72 in. lb. (5,4-8,1 N.m).
9. Install the sterndrive and adjust the shift system following the instructions under **Sterndrive Removal and Installation**.
10. Refer to the **Propeller Selection** section found elsewhere in this manual for procedures to install the propellers.



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33836

11. If the sterndrive is not to be installed, install the shift linkage access cover and secure with three screws. Tighten the screws to 108-132 in. lb. (12-15 N.m).

12. After drive has been run, recheck oil level. Add make-up oil through the dipstick opening to bring oil up to the proper level within range on the dipstick.

Anode - Testing and Replacement

Anode erosion or disintegration in salt or brackish water indicates they're performing their function. Anodes should be inspected and/or replaced at intervals, or corrosion of the drive will increase.

Note! If any anode has been reduced to two-thirds its original size (one-third eroded), it must be replaced.

Test for proper installation of the anode. Set an ohmmeter to the low ohms scale. Connect one ohmmeter lead to a good ground, and the other to the anode. Be sure anode surface is clean to make good contact. Ohmmeter should indicate a very low reading (zero). If not, remove the anode and clean the mounting screws, the anode, and the area where the anode is installed. Install and retest the anode.

Note! Do not paint or otherwise coat the anodes. This will prevent them from functioning properly. If anode appears to be corroded on its surface, but is not deteriorating, it should be replaced.

Specifications

Table 5:

Description	U.S.	Metric
Nut		
Pinion gear	72-87 ft. lb.	98-118 N•m
Lower to upper gearcase 3/8-16	22-24 ft. lb.	30-33 N•m
Screw		
Anode	60-84 in. lb.	6,8-9,5 N•m
Drain	10-15 ft. lb.	14-20 N•m
Exhaust cover	14-17 ft. lb.	19,5-22,5 N•m
Lower to upper gearcase 3/8-16	22-24 ft. lb.	30-33 N•m
7/16-14	32-40 ft. lb.	43-54 N•m
Oil level dipstick and plug	48-72 in. lb.	5,4-8,1 N•m
Shift Lever Access Cover	108-132 in. lb.	12-15 N•m

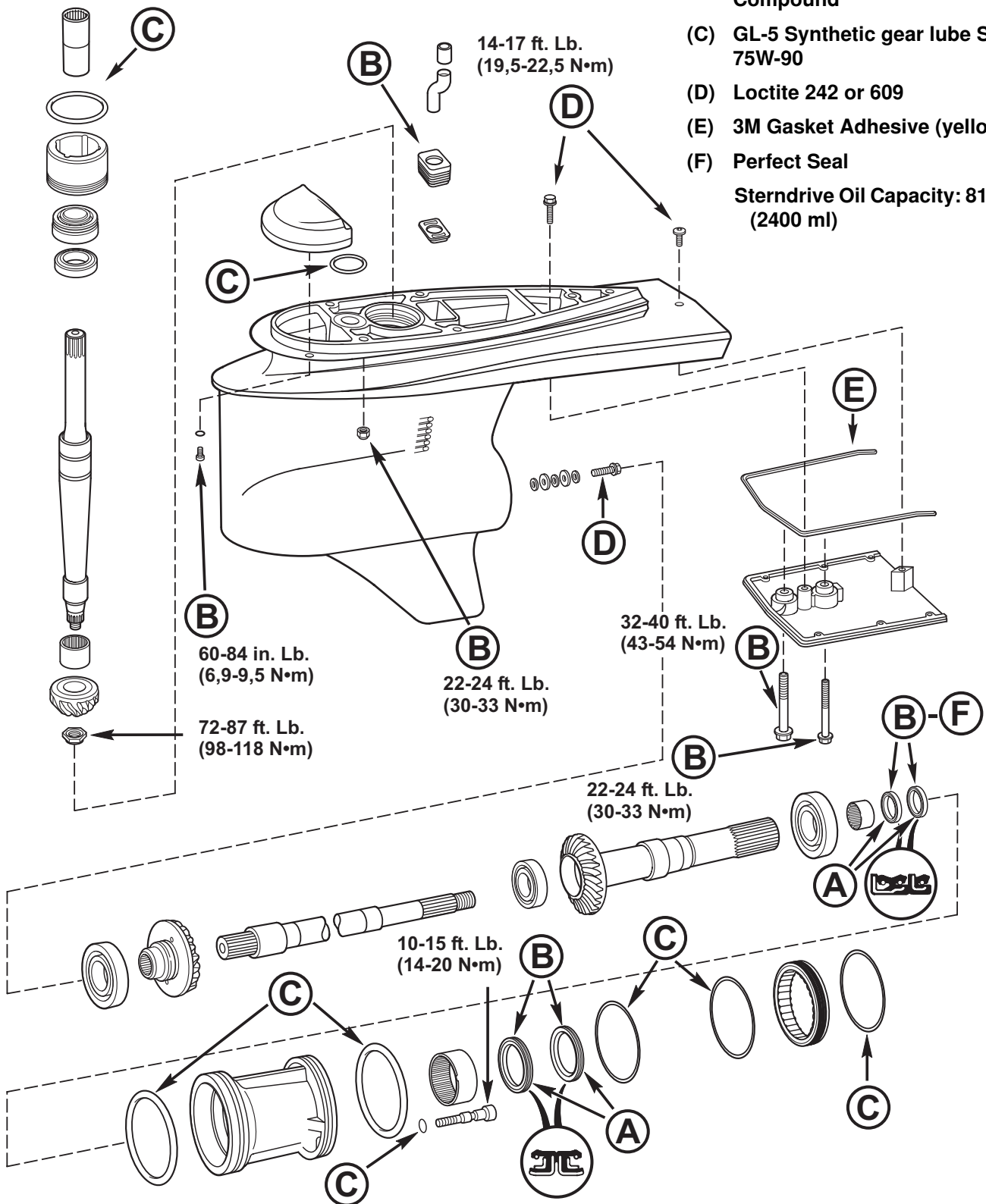
Sealants, Lubricants and Adhesives

Table 6:

Type	Chemical	Where Used
Primer	<i>Loctite</i> Primer	Exhaust cover screws Magnet screw Outer propeller shaft sleeve Vertical driveshaft sleeve Upper gear housing stud
Adhesive	<i>Volvo Penta Thread Locking Fluid</i> P/N 1161053	Exhaust cover screws Magnet screw Outer propeller shaft sleeve Vertical driveshaft sleeve Upper gear housing stud
	3M Gasket Adhesive (yellow)	Exhaust cover seal
Lubricants	Volvo Penta Grease P/N 828250	All Seal lips Shim ring, propshaft bearing housing.
	GL-5 Synthetic Gear Lubricant SAE 75W-90	All bearings, gears. Threads, retainer ring. All O-rings.
Sealants	Volvo Penta Gasket Sealing Compound	O.D. all metal case seals. Dipstick and plug, gearcase oil level. Screw, drain. Screws, lower to upper gearcase. Screw, propshaft bearing housing retainer. Seal, water tube. O.D. all rubber case seals.

Service Chart

- (A) Volvo Penta Grease P/N 828250
 - (B) Volvo Penta Gasket Sealing Compound
 - (C) GL-5 Synthetic gear lube SAE 75W-90
 - (D) Loctite 242 or 609
 - (E) 3M Gasket Adhesive (yellow)
 - (F) Perfect Seal
- Sterndrive Oil Capacity: 81 oz.
(2400 ml)**



DR6400

Notes

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Sterndrive Removal and Installation

Table of Contents	Sealants, Lubricants and Adhesives	233
	Sterndrive Removal	233
	Sterndrive Installation	236
	Check and Adjust Trim Sending Unit	241
	Shift and Throttle Cable Installation	241
	Shift Cable Installation	242
	Throttle Cable Installation	245

Sealants, Lubricants and Adhesives

Motor Oil

Volvo Penta White Sealing Compound for Drives P/N 1141570

Volvo Penta Grease P/N 828250

Molybdenum Trioxide (Moly) Grease

Wheel Bearing Grease

Safety Warnings

Before beginning work in this section, read Safety chapter at end of this manual. Proper installation is important for the safe, reliable operation of all mechanical products. The procedures we recommend and describe in these instructions are effective methods to be followed when installing *Volvo Penta* stern drive products. Some of these methods require the use of tools specially designed for the purpose. The special tools should be used when and as recommended.

Special Tools

Table 1:

Tool Name	Volvo P/N	Panel Location
Alignment Tool	3851083	K
Universal Handle	3850609	A

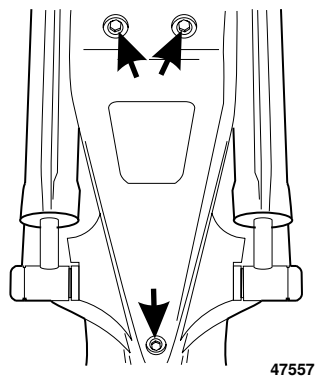
Sterndrive Removal

Special Tools Required:

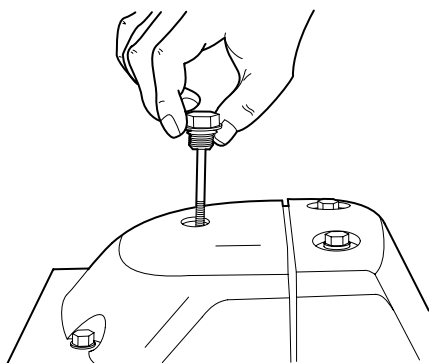
- Hoist Capable of Lifting at Least 500 lb. (227 kg), or Sterndrive Dolly
- Lifting Eye (1/2-13 thread)
- Sterndrive Holding Fixture

Note! The boat must be out of the water on a trailer, or in a cradle, for removal of the sterndrive. When a sterndrive dolly is used for removal, omit steps 1 and 2.

1. Remove and retain the three shift linkage access cover screws and cover.

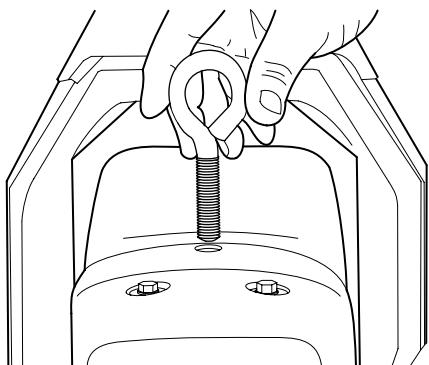


2. Remove dipstick from upper gear housing.

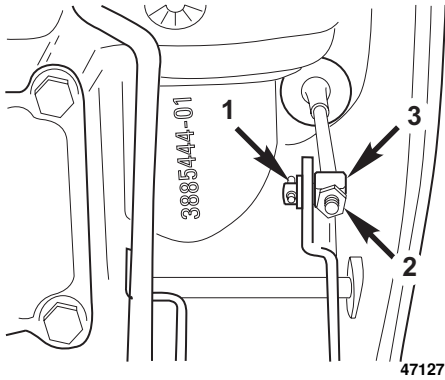


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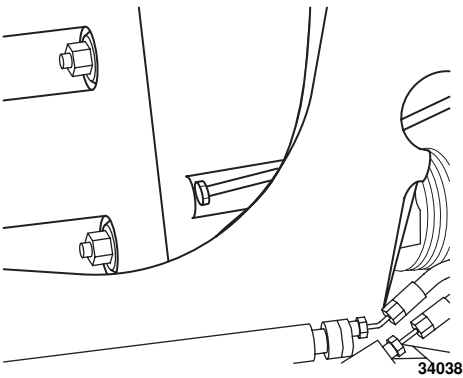
3. Fully thread a lifting eye into upper gear housing oil indicator hole.



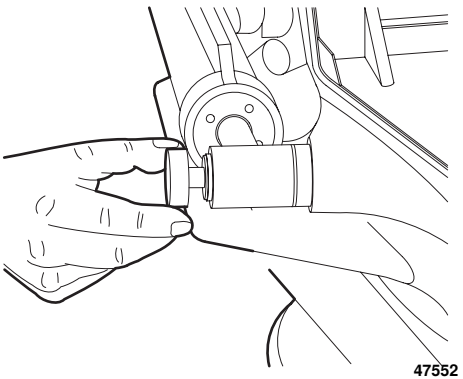
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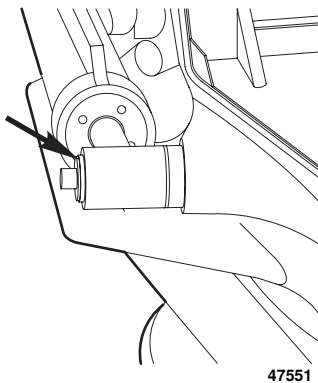
4. Remove jam nut (2) from shift cable. Remove cotter pin (1) and washer from cube. Un-thread the cube (3) from the shift cable.



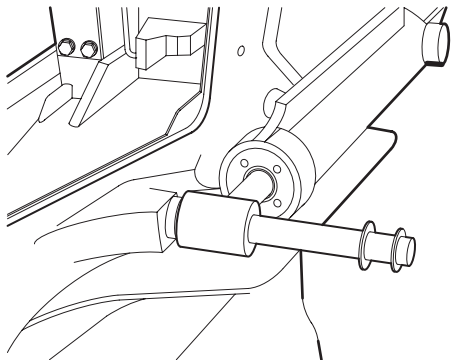
5. Loosen screw securing cable anchor clamp. Slide the anchor to starboard to unfasten the shift cable. Turn the sterndrive to port and remove the shift cable.



6. Remove and retain end cover.

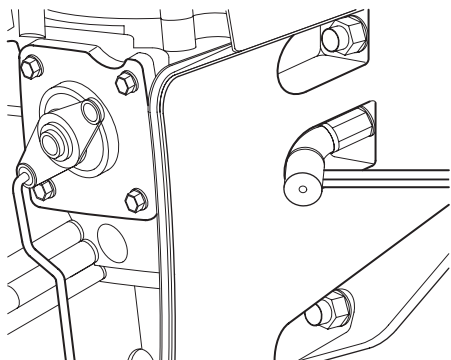


7. Remove e-clip and flat washer from trim/tilt pivot rod.



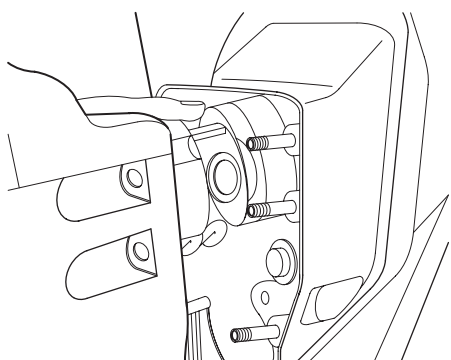
47550

8. **NOTE:** Use a soft hammer to lightly tap trim/tilt pivot rod out of trim/tilt cylinder. Support hydraulic cylinders while removing pivot rod. Carefully lower each hydraulic cylinder to rest on the spray plate after pivot rod is removed.



47129A

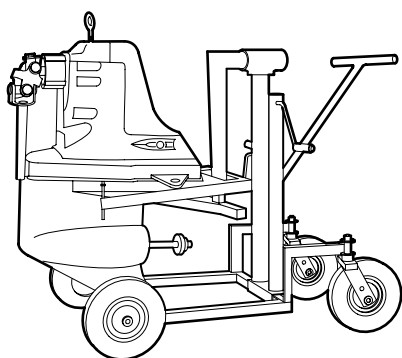
9. **Attach a hoist capable of lifting at least 500 lb. (227 kg) to lifting eye, or use a dolly to hold sterndrive.** Remove and discard six lock nuts.



34055

10. Pull sterndrive away from transom bracket and support driveshaft and universal coupler.

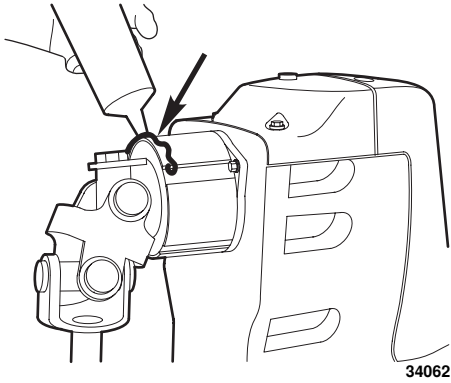
Sterndrive Installation



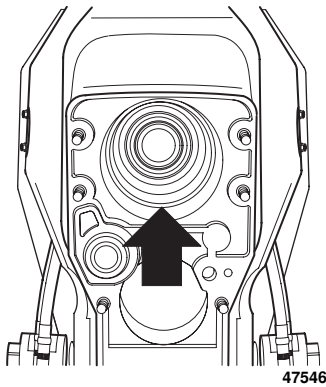
34065

1. Remove dipstick and o-ring. Install a lifting eye into the dipstick hole. A sterndrive cart may also be used if access is blocked by a swim platform.

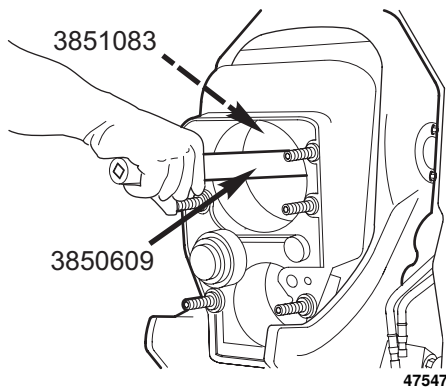
2. Apply a light coat of *Volvo Penta Grease P/N 828250* to tapered end of pinion bearing carrier.



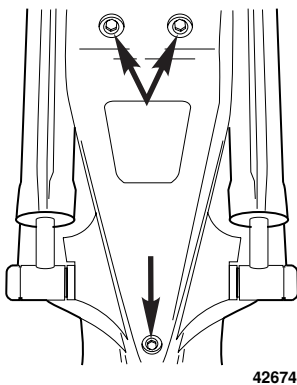
3. Inspect molded rubber seal ring for proper fit in its groove. Inspect and lightly lubricate Universal Joint bellows lip with *Volvo Penta Grease P/N 828250*.



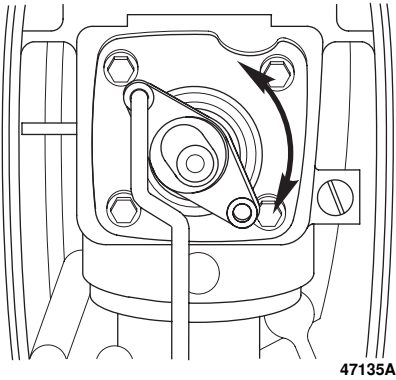
4. Assemble Alignment Tool, *Volvo Penta P/N 3851083*, and Universal Handle, *Volvo Penta P/N 3850609*. Slide alignment tool through gimbal bearing. The alignment tool must slide through the gimbal bearing and into engine coupler with ease. If the alignment tool binds going into engine coupler, the front engine mount(s) must be adjusted either "up" or "down, or side-to-side" as required, until alignment tool slides in and out of engine coupler with ease.



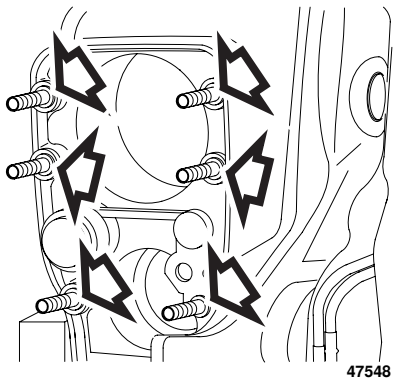
5. Remove and retain the three shift linkage access cover screws and cover.



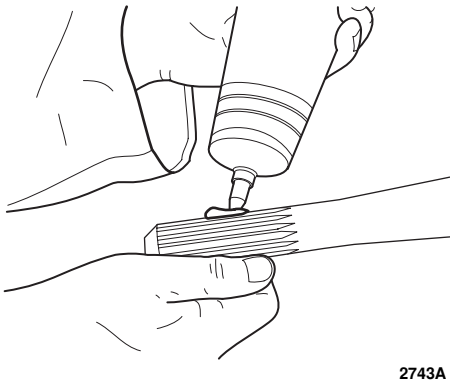
- Shift sterndrive into gear by rotating the eccentric piston arm either up or down.



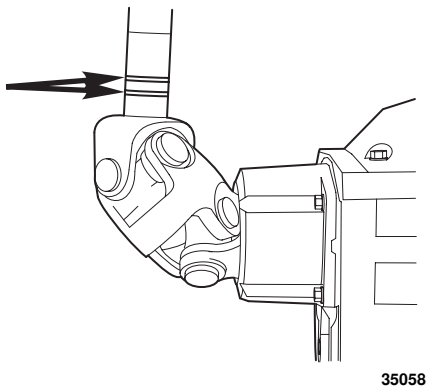
- Apply White Sealing Compound For Drives to the six studs.

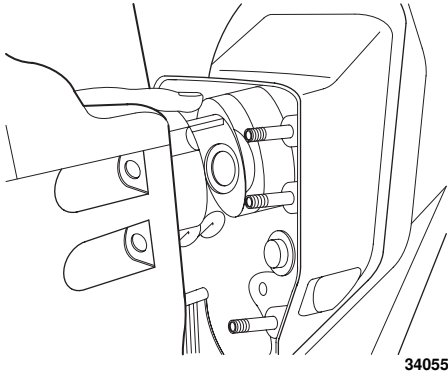


- Lubricate the driveshaft splines with Molybdenum Trioxide (Moly) Grease.

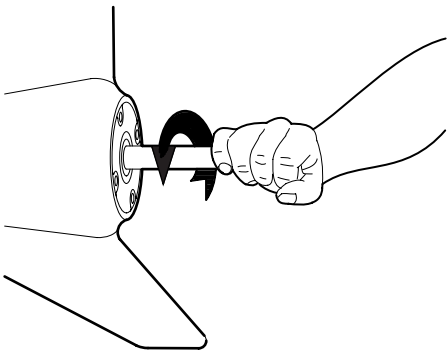


- Lightly lubricate the two driveshaft O-rings with *Motor Oil*. Grease in the O-ring grooves can hydraulically lock the O-rings and cause difficulty starting the driveshaft into the gimbal bearing.

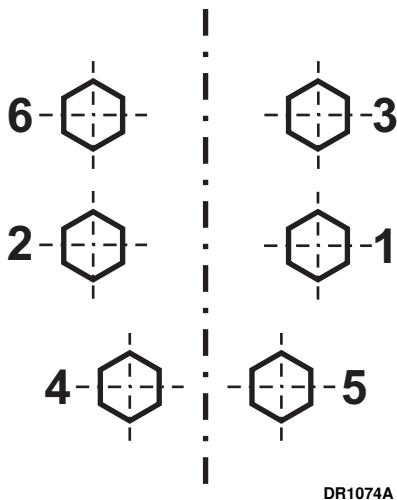




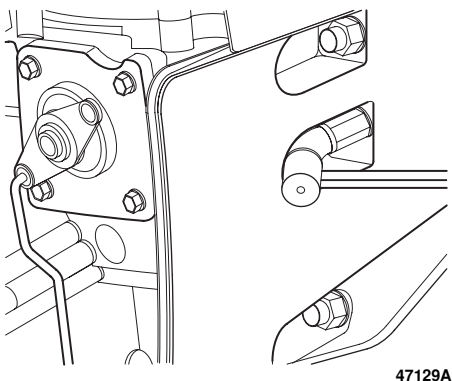
10. Lift the trim/tilt hydraulic cylinders and rest them on the spray plates. Slide driveshaft and universal coupler into Universal Joint bellows.

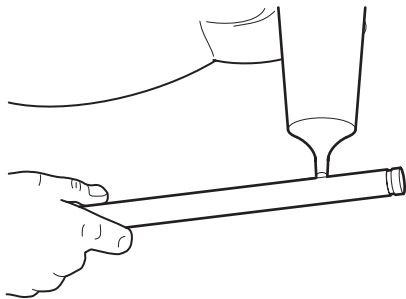


11. To align the driveshaft splines, rotate propeller shaft until the driveshaft splines engage the flywheel coupler.
12. Slide sterndrive onto the six studs until it is completely seated against the pivot housing. Install six locknuts (three on each side).



13. Tighten the nuts in two steps. Use a 3/8 in. drive, 5/8 in. swivel socket to tighten nuts to an initial setting of 25 ft. lb. (34 N.m). Start with the center nut and work in a crisscross pattern to secure the sterndrive to the pivot housing. Use the same crisscross pattern to tighten all six locknuts to a final setting of 50 ft. lb. (68 N.m).



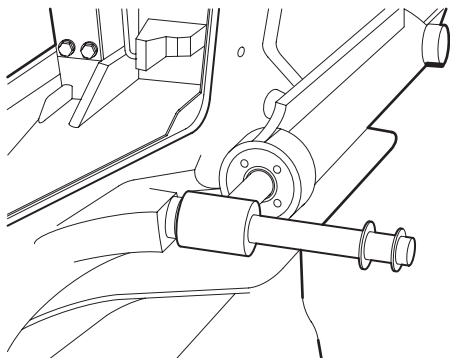


47549

14. If a sterndrive cart has been used, remove it at this time for installation of the trim/tilt cylinders. Apply *Volvo Penta Grease P/N 828250* to the trim/tilt pivot pin.

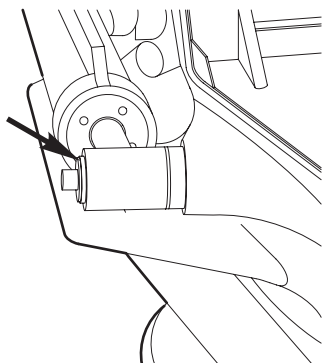
15. Install bushings in upper housing boss.

Note! Use care when installing trim/tilt pivot pin, bushings can be damaged.



47550

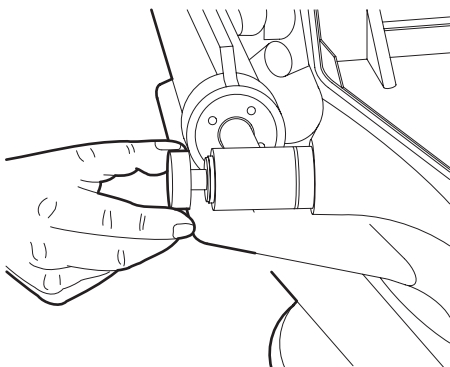
16. Align trim/tilt cylinder end with upper housing boss. Slide trim/ tilt pivot pin through trim/tilt cylinder and upper gear housing.



47551

17. Align and slide pivot pin through trim/tilt cylinder end. Install flat washer and E-clip.

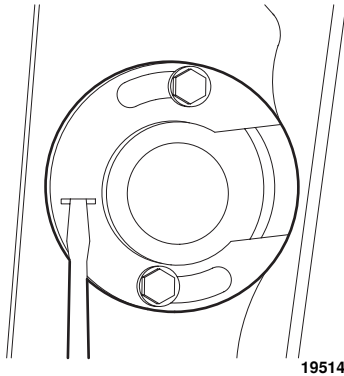
Note! The e-clip must be installed in the inner groove of the pivot pin. The washer must be installed between the e-clip and the rod end.



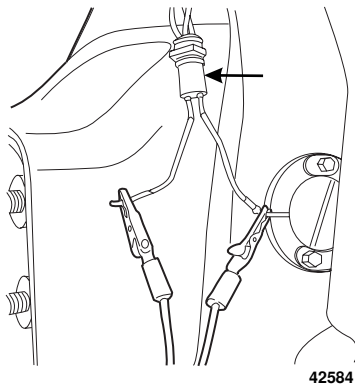
47552

18. Install rod end covers onto pivot pin.

Check and Adjust Trim Sending Unit



19514



42584

Note! Push trim/tilt switch to the down position. Sterndrive must be in a full trim-in position before adjusting the trim sending unit.

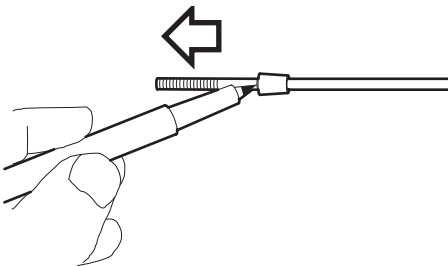
1. Turn steering wheel to full port for access to trim gauge sending unit. Loosen trim gauge sending unit screws on starboard side of gimbal ring.
2. Unplug the trim sending unit connector from the wiring harness. Connect an ohmmeter to the connector. Rotate trim gauge sending unit to obtain a 11 ± 1 ohm reading on the ohmmeter.
3. Tighten trim gauge sending unit screws to 24 in. lb. (2,7 N.m).

Shift and Throttle Cable Installation

1. If the remote control shift and throttle cables are installed in the remote controls, proceed to **Check Remote Control Shift Cable Stroke**.
2. If the remote control shift and throttle cables have not been installed, refer to the installation instructions of the remote control for installation of the shift and throttle cables.

Note! Check installation of shift cables. Shift cable should “PULL” for forward gear on right-hand rotation SX and DP-S propeller applications. Shift cable should “PUSH” for forward gear on left-hand rotation SX propeller applications. This change is accomplished by cable installation in the remote control box.

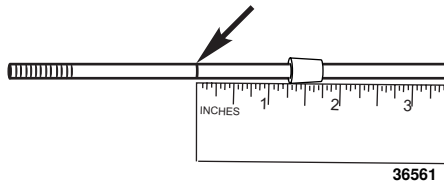
Check Remote Control Shift Cable Stroke



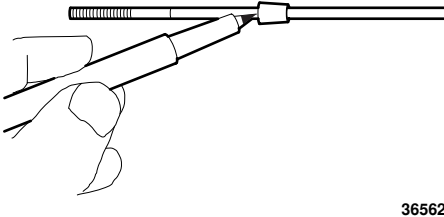
36560

1. Move remote control handle to the wide-open-throttle position in the direction needed to retract the shift cable. Pull out cable core wire to remove end play. Mark cable core wire at end of casing.

2. Return remote control shift handle to the neutral detent position. Measure and record the distance between mark and end of casing.



3. Mark cable core wire at end of casing with control in the neutral detent position.



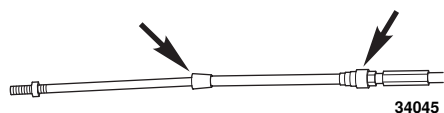
4. Move the remote control handle to the wide-open-throttle position in the direction to extend the shift cable. Push in on cable core wire to remove end play. Measure and record the distance between mark and end of casing.

- The distance between forward and neutral must be **no less than 1-1/4 in. (31,8 mm) and no greater than 1-3/8 in. (35,0 mm)**.
- The distance between neutral and reverse must be **no less than 1-1/4 in. (31,8 mm) and no greater than 1-3/8 in. (35,0 mm)**.

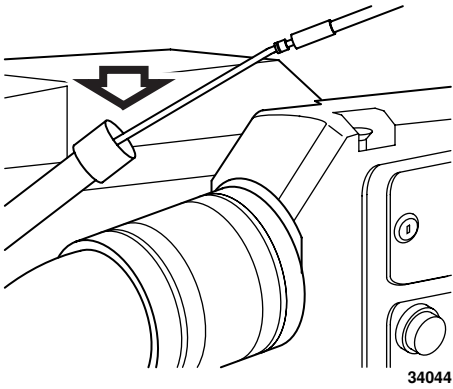
Note! Check your remote control installation instructions, if your measurements are not within these specifications. Make sure the cables are attached correctly inside the control box before continuing. All control boxes must meet these minimum and maximum specifications in order for the shift system to function properly.

Shift Cable Installation

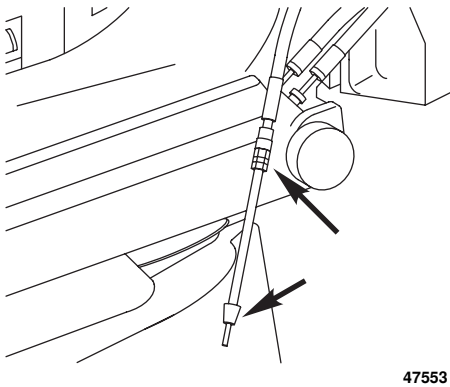
Note! Remote control shift and throttle cables must be SAE type cables.



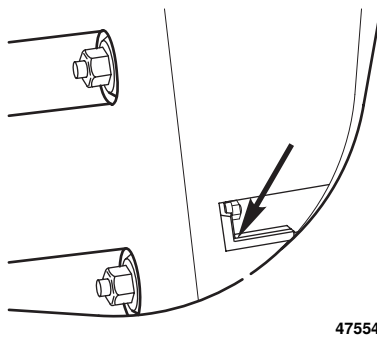
1. **NOTE:** If the throttle cable is attached to the throttle arm and anchor block, remove it from both. The throttle cable must be disconnected from the throttle arm prior to shift cable installation and adjustment to prevent "loading" the control box and adversely affecting shift adjustments.
2. Note position of small seal and large seal of the shift cable. Remove and retain jam nut, small seal, and large seal from the shift cable.



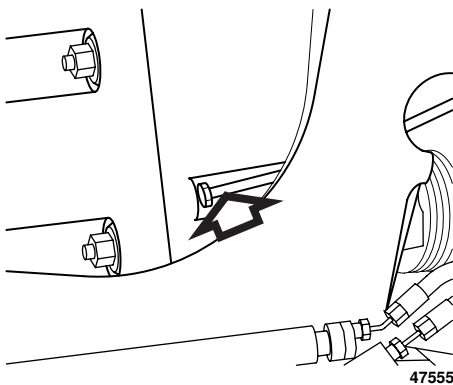
3. Apply a light coat of *Volvo Penta Grease P/N 828250* to the end of the remote control shift cable casing. Slide shift cable through transom sleeve and connector assembly until it appears on the outside of the transom.



4. For ease of installation of shift cable, turn sterndrive to port. Reinstall the retained large seal and small seal onto the shift cable in the same position as noted in step 2.

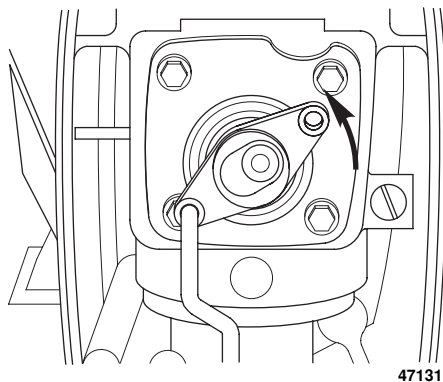


5. Loosen cable anchor clamp and slide to starboard.



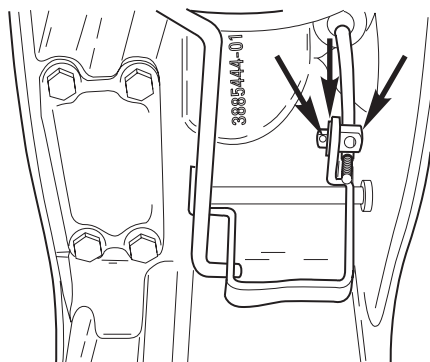
6. Slide shift cable through pivot housing and sterndrive. Slide anchor clamp in, engaging the shift cable anchor groove. **Tighten anchor clamp screw securely.**

7. Rotate eccentric piston arm to extend bellcrank.



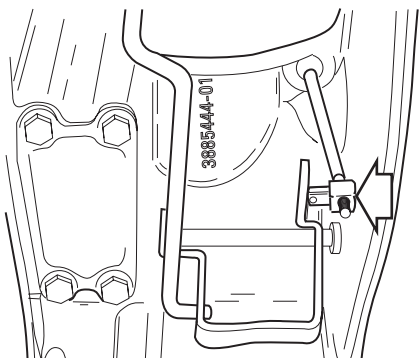
47131

8. Remove cotter pin, flat washer, and cube.



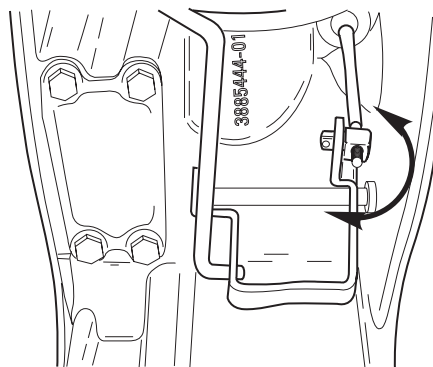
47132

9. Thread cube halfway onto remote control cable end.

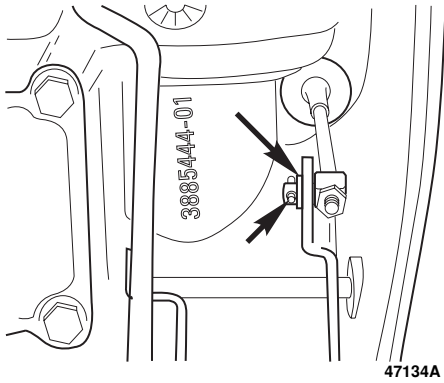


47130

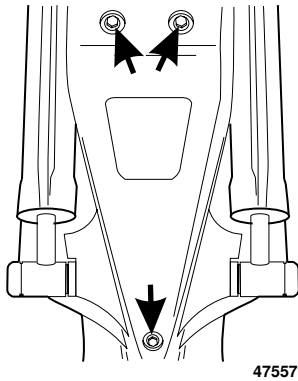
10. Rotate shift lever back to neutral detent position, then move remote control handle to its neutral detent position. Turn cube **IN** or **OUT** until it aligns with center of bellcrank slot.



47133

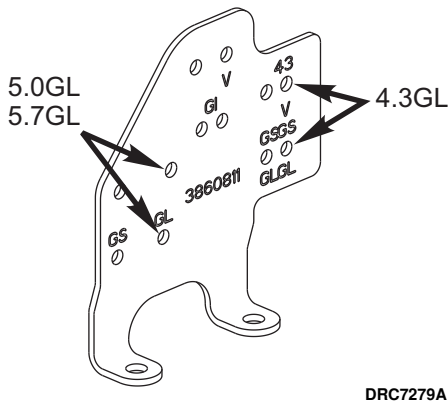


11. Install flat washer and cotter pin. **Bend prongs of cotter pin for a secure attachment. Install jam nut and tighten securely against cube to keep cable from turning in cube.**



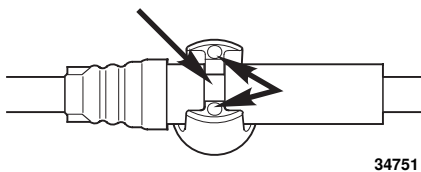
12. Reinstall shift linkage access cover and secure with three original screws.

Throttle Cable Installation

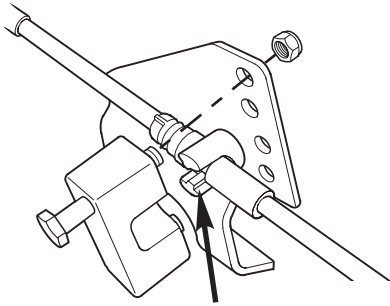


Note! V6 and V8 Carbureted Models Only: The engine throttle cable anchor block bracket has several sets of anchor block holes. The sets of holes marked with a "V" are used for *Volvo Penta* remote controls. Check the anchor block position for your particular engine and remote control operation. Change as necessary.

Move remote control handle to the **NEUTRAL** detent position. Turn propeller shaft and shift into the forward gear detent position, and then pull **HALFWAY BACK** towards **NEUTRAL**. This positions the control for proper throttle cable adjustment. **Failure to follow this procedure can bind the shift linkage in the control, and produce "hard shifting".**



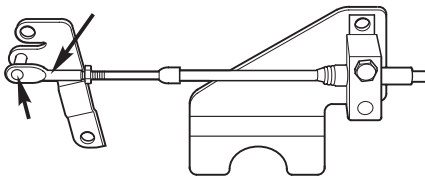
1. Align internal bosses of trunnion with throttle cable groove. Press trunnion on throttle cable until seated.



DR4977

2. Install open end of trunnion in anchor block. Install screw in anchor block and position throttle cable assembly in selected set of holes. **Locknut must be against the anchor bracket, tighten it securely.**

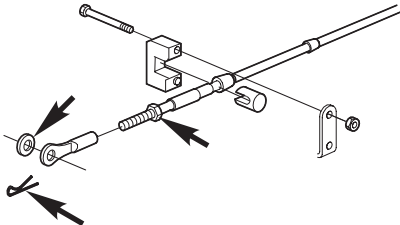
Throttle arm pin is for or **Pull-To-Open** throttle operation. Check the operation of your remote control before attaching the throttle cable to the throttle arm. **Improper matching of the remote control throttle operation to the throttle arm will result in an engine that will accelerate when you are attempting to stop.**



DR5095

3. **Throttle arm connector must have a minimum of 9 full turns or 1/4 in. of throttle cable thread engagement.** Install throttle arm connector onto the throttle cable. Pull connector forward to remove all end play from remote control throttle cable, then turn the connector in until hole aligns with the throttle arm.

Note! If throttle arm connector hole cannot be adjusted to align with the throttle arm, check for proper cable installation in the remote control box.



23051

4. Install connector onto throttle arm. Install washer and cotter pin. Spread prongs of cotter pin for a secure attachment. Tighten jam nut against connector.

Trim/Tilt Hydraulic System

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Sealants, Lubricants and Adhesives

Volvo Penta Thread Locking Fluid P/N 1161053

Black Neoprene Dip

Loctite Primer

Volvo Penta Grease P/N 828250

Volvo Penta Power Trim/Tilt & Steering Fluid

Dexron Automatic Transmission Fluid

Cleaning Solvent *Dexron Automatic Transmission Fluid*

Cleaning Solvent

Safety Warnings

Before working on any part of the trim/tilt system, read the section called Safety at the end of this manual.

When replacement parts are required, use genuine *Volvo Penta* or parts with equivalent characteristics including type, strength and material. Failure to do so may result in product malfunctions and possible injury to the operator and/or passengers.

Special Tools

Tool Name	Volvo P/N	Panel Location
Adaptor, Pressure Tester	3854366-6	K
In-Line Pressure Tester	3854368-2	K
Rod Holder	3854367-4	K
Seal Installer	3854364-1	K
Spanner Wrench	3854365-8	A

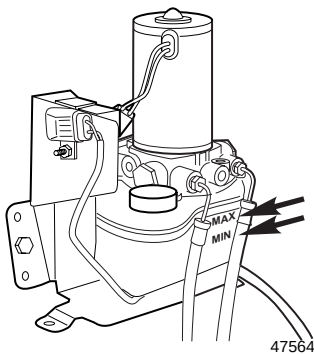
System Description

The trim/tilt unit consists of a valve body, oil pump, and electric motor assembly connected to two hydraulic cylinders. A trim sending unit is mounted to the starboard side of the gimbal ring and connected to a dash mounted trim gauge.

To operate the trim/tilt, push the switch to the desired bow-up/ bow-down position. Holding the switch in the desired position will activate the system until the switch is released. Holding the switch in the bow-up position, the electric motor drives the hydraulic oil pump forcing oil into the base of the hydraulic cylinders. The force developed by the cylinder moves the sterndrive through an unlimited trim range.

The dash mounted trim gauge indicates the bow position that is controlled by the trim angle of the sterndrive. Continued operation in the bow-up direction tilts the sterndrive to the full tilt-up position. (The trim gauge indicates full bow-up position when in the tilt range.) Holding the switch in the bow-down position, the sterndrive will move down through the tilt range into the trim range. If the trim switch is not released the sterndrive will move through the trim range to the full bow-down position.

Reservoir - Checking, Filling and Bleeding



At the beginning of each boating season, check the fluid level in the reservoir as follows:

- Level should be between the “MIN” and “MAX” marks on the reservoir.
- If necessary, add *Volvo Penta* Power Trim/Tilt and Steering Fluid, or *Dexron* Automatic Transmission Fluid. Add as required. Replace the cap and tighten securely.

When checking fluid level, inspect the trim/tilt unit for leaks and proper operation.

Note! In situations where air has entered pump and hydraulic lines because of low fluid level, or any part of system has been disassembled, it will be necessary to bleed (purge) air from system. To remove air from hydraulic system, cycle trim/tilt system a minimum of five times, adding fluid as required.

Troubleshooting - General

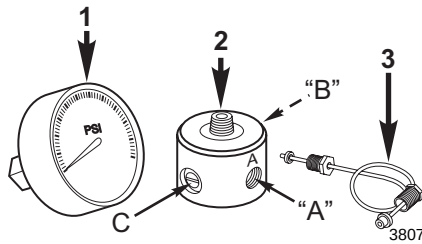
In many cases an inspection or test of the “easy things” first will reveal the problem quickly and save valuable troubleshooting time.

1. **Visual inspection:** Look for indications of external oil leaks. Repair as necessary. Check reservoir oil level.

Note! Do not remove fill plug unless the sterndrive is in the full tilt-up position. Fill as required, see **Reservoir - Filling and Bleeding**.

2. **Battery:** The battery must be fully charged for some of the following tests. A fully charged battery will have a specific gravity of 1.260 to 1.280.

Troubleshooting With In-Line Pressure Tester



The Trim/Tilt In-Line Pressure Tester, P/N 3854368, provides a method for checking the performance of the trim/tilt unit. The pressure tester can measure running pressure, stall pressure, and pressure leak-down. The tester can isolate the trim/tilt cylinders from the valve body to help locate a component causing leak-down.

The trim/tilt in-line pressure tester consists of a pressure gauge and adapter (1), a tester body and shut-off valve assembly (2), and a hydraulic line assembly (3).

The tester body is designed so the hydraulic port stamped "A" is always connected to the gauge. Hydraulic port stamped "B" opposite the valve (C) can be shut off by closing the valve. If you suspect that a valve or cylinder is leaking, the tester may be connected to the trim/tilt valve body four different ways to isolate and test components of the trim/tilt circuit.

How to Install Tester

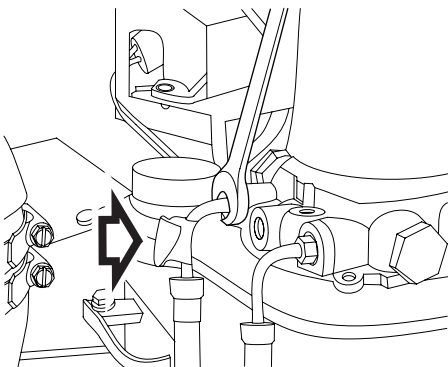


Warning!

Wear safety glasses. Some residual pressure may be present in the trim/tilt system when the hydraulic line is loosened. Always wrap a shop cloth around the hydraulic fitting before loosening. This will trap any oil as the fitting is loosened. Spray could cause eye injury.

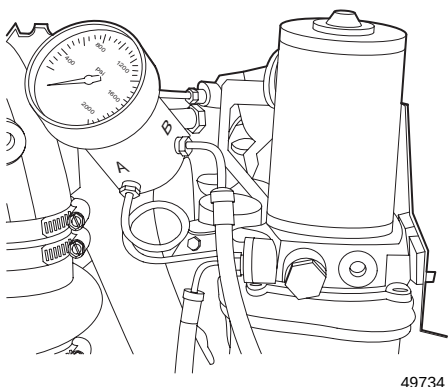
Catch any oil with a shop cloth and drip pan.

1. Before disconnecting any hydraulic lines, tag the line connected to the port marked ("UP") for identification.



System Hydraulic Tests

Test No. 1 - Complete Up Circuit



This test will provide running and stall PSI for the trim-out/tilt-up circuit.

1. Disconnect hydraulic line from the "UP" port of the pump manifold.
2. Connect tester hydraulic line to "UP" port in pump manifold, and to outlet "A" on tester body.
3. Connect hydraulic line removed from the "UP" port, to opening "B" in tester body.
4. Open tester shut-off valve one to two turns. **Do not open more than two turns; valve retaining ring may unseat and cause hydraulic fluid spray.**
5. Run drive through a complete trim-out/tilt-up cycle. Record running and stall PSI and compare to specifications.

Test Results: If system fails to meet specifications, perform **Test No. 2.**

Test No. 2 - Pump Isolation, Up Circuit

This test will isolate the pump manifold trim-out/tilt-up components from the trim cylinders. It will help determine whether defective components are in the pump manifold, or in the trim/tilt cylinders.

1. Follow **Steps 1-5** under **How to Install Tester** and connect the tester as described in **Test No. 1.**
2. Run the drive to the full tilt position. Momentarily activate the trim switch in the DOWN direction to relieve pressure on gauge.
3. Completely close the tester shut-off valve.
4. Run pump in the trim-out/tilt-up direction and record the stall PSI. Release the trim switch and check the leak down rate and final PSI. Compare the results to the specifications.

Test Results: If the pressure gauge shows a stall PSI less than specifications, or a leak down rate greater than specifications, the problem lies within the pump manifold.

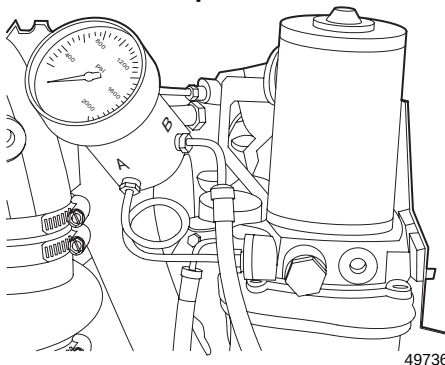
If the stall PSI and leak down figures are within specifications, the problem is with either or both trim/tilt cylinders.



Warning!

Do not disconnect any lines if pressure still registers on gauge. This may cause a hazardous spray of high pressure hydraulic fluid. To relieve pressure, momentarily activate trim in opposite direction of last use. Watch gauge to make sure it registers zero before removing lines.

Test No. 3 - Complete Down Circuit



This test will provide running and stall PSI for the trim-in/tilt-down circuit.

1. Disconnect hydraulic line from the "DN" port of the pump manifold.
2. Connect tester hydraulic line to "DN" pump port, and to opening "A" on tester body.
3. Connect hydraulic line removed from the "DN" port to opening "B" on tester.
4. Open tester shut-off valve one to two turns.



Warning!

Do not open more than two turns; valve retaining ring may unseat and cause a hydraulic fluid spray.

5. Run drive through a complete trim-in/tilt-down cycle. Record running and stall PSI, and compare to specifications.

Test Results: If system fails to meet specifications, perform **Test No. 4.**

Test No. 4 - Pump Isolation, Down Circuit

This test will isolate the pump manifold trim-in/tilt-down components from the trim cylinders. It will help determine whether defective components are in the pump manifold, or in the trim/tilt cylinders.

1. Attach the tester as described in **Test No. 3.**
2. Run drive to the full down position. Momentarily activate trim switch in the UP direction to relieve pressure on gauge.

3. Completely close the tester shut-off valve.
4. Run pump in the trim-in/tilt-down direction and record the stall PSI. Release the trim switch and check the leak down rate and final PSI. Compare the results to specifications.

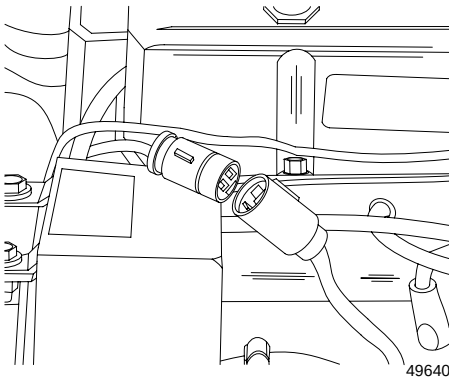
Test Results:

If the pressure gauge shows a stall PSI less than specifications, or a leak down rate greater than specifications, the problem lies within the pump manifold.

If the stall PSI and leak down figures are within specifications, the problem is with either or both trim/tilt cylinders.

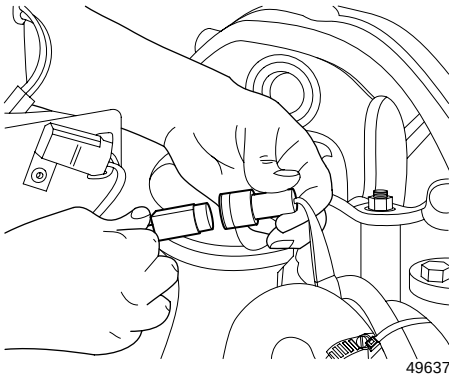
Servicing Motor and Pump

Removing Motor and Draining Reservoir

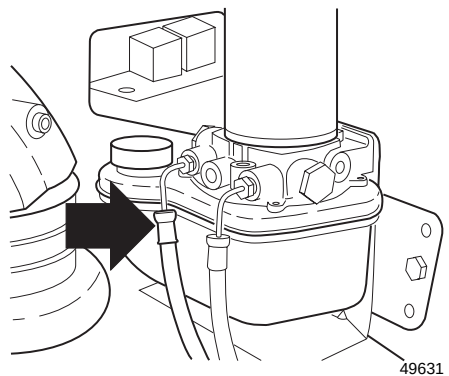
**Warning!**

The hydraulic lines may contain fluid under pressure. All of the pressure can not be relieved before the system is opened. Safety Glasses must be worn. All line fittings must be covered with shop towels before they are opened. DO NOT remove any lines completely before the pressure is relieved.

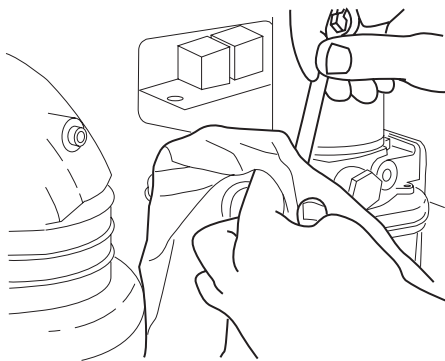
1. Disconnect the three wire trim/tilt connector going to the remote control.



2. Disconnect the two wire trim/tilt power connector.



3. Tag the hydraulic line going to the "UP" port of the trim/tilt pump.



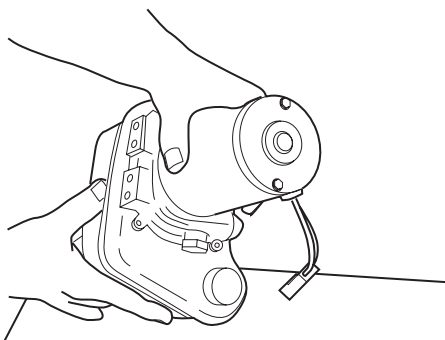
49632



Warning!

Wear safety glasses. Cover the hydraulic lines with a shop towel to prevent dangerous spray and carefully remove. There could be some residual pressure remaining in the line. Place line in container to catch fluid.

4. Place plugs in valve body to prevent dripping of residual fluid.
5. Unscrew hardware holding pump assembly to transom. Remove the pump assembly from the boat.

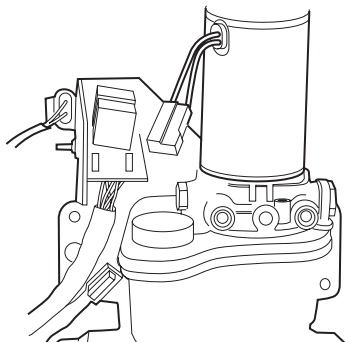


49697

6. Drain any oil remaining in reservoir into a suitable container. This fluid should not be reused. Dispose of the fluid in an appropriate manner.

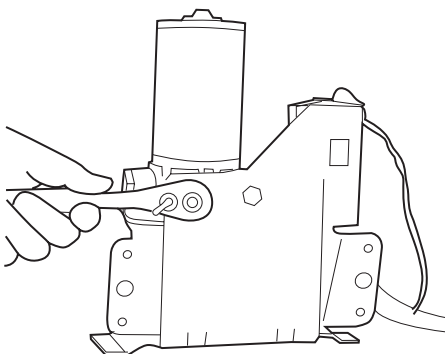
Note! It is necessary that the outside surface of the trim/tilt unit be completely free of dirt prior to disassembly. Wipe with a cleaner if necessary. Always use a lint-free cloth when handling trim/tilt components.

Separation of Reservoir and Motor



49633

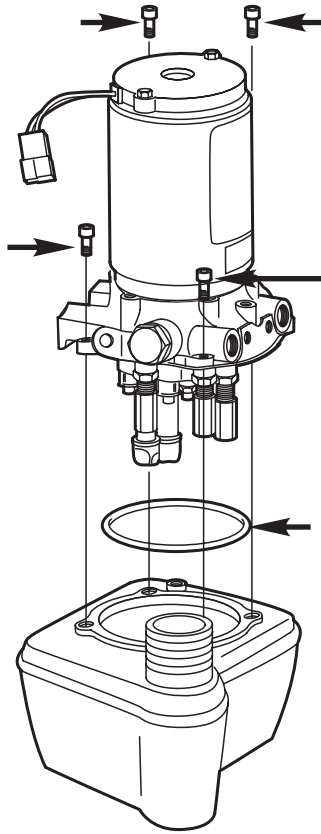
1. Disconnect pump motor from trim/tilt wiring harness.



49635

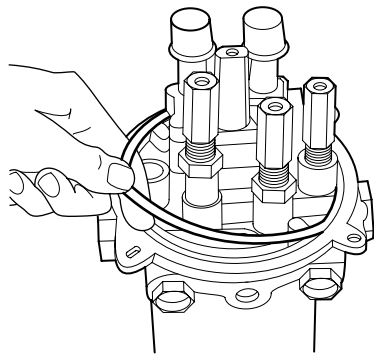
2. Remove two screws securing trim/tilt assembly to bracket.

3. Remove four #6 allen screws securing reservoir to manifold.



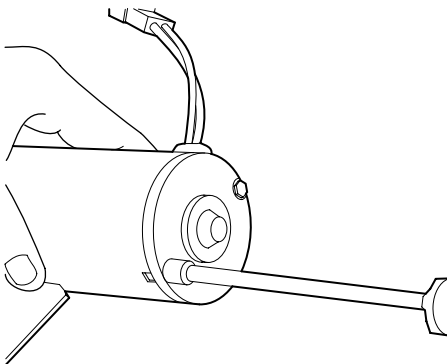
22881

4. Remove O-ring from manifold.



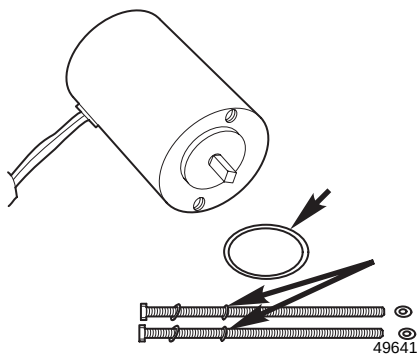
49699

5. Remove two screws securing motor to manifold.

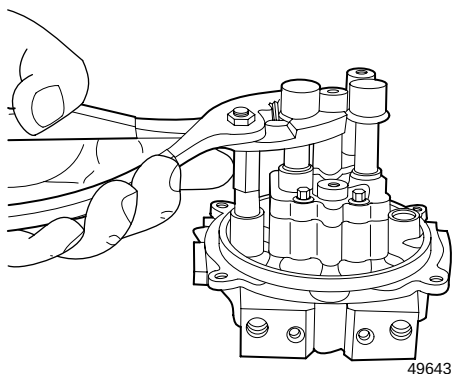


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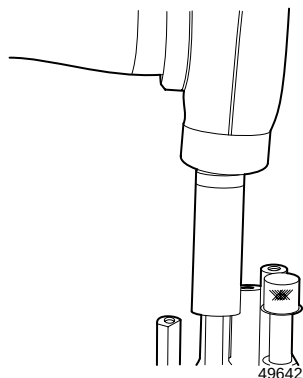
6. Discard O-ring on motor and four O-rings on screws.



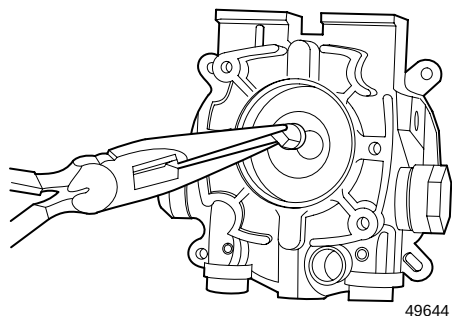
7. Remove and inspect filters. Clean or replace as necessary.



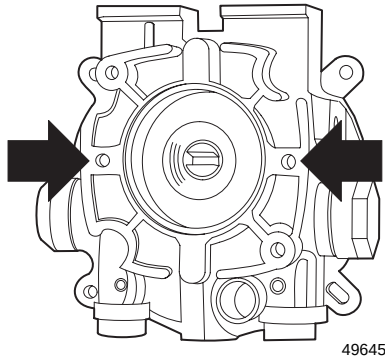
8. Install filters using a socket or suitable tool. Drive the filters into place. The end of the pick-up tube should not touch the filter.



9. Pull out pump drive coupling and inspect for wear or damage.



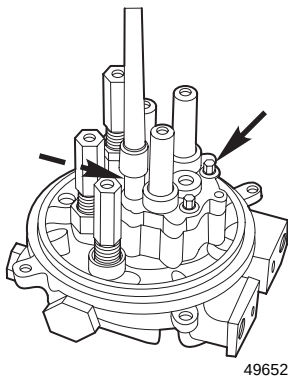
10. Install the pump coupler and align the slot with the two pump motor mounting holes.



Separation of Pump and Manifold

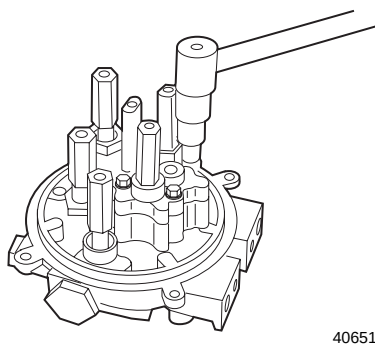
Note! Mating surfaces between pump and manifold are critical for sealing, and cannot be scratched or gouged. Use extreme care during disassembly and reassembly procedures. The pump is serviced as an assembly. Do not attempt to disassemble the pump or try to put a reassembled pump back into service. Reassembled pumps have a very short service life.

Remove two pump mounting screws. The two remaining screws are not to be removed.

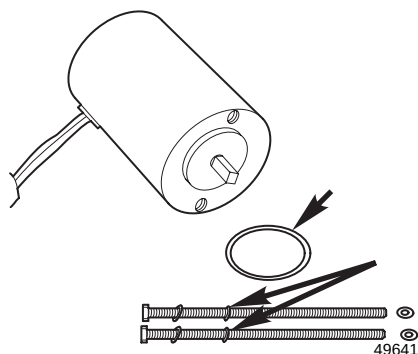


Installation of Pump

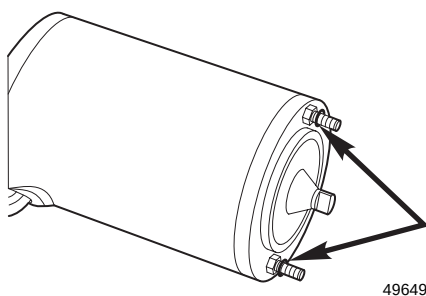
Rest pump on manifold. Install screws. Tighten screws to 35 in. lb. (4,0 N.m).



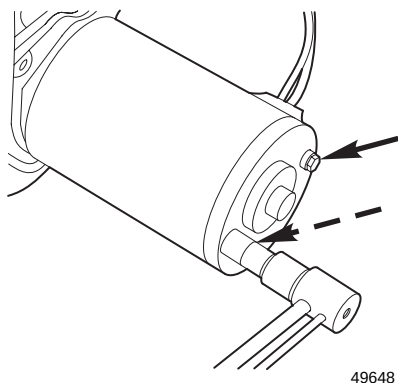
Installation of Motor and Reservoir



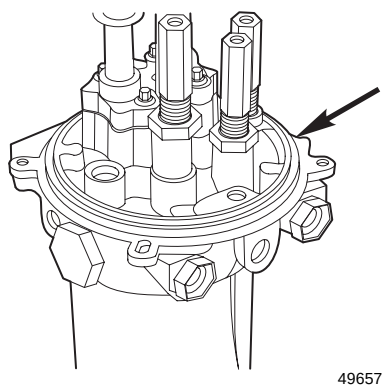
1. Coat O-ring with *Volvo Penta* Power Trim/Tilt and Steering Fluid, or *Dexron* Automatic Transmission Fluid. Position O-ring on motor.



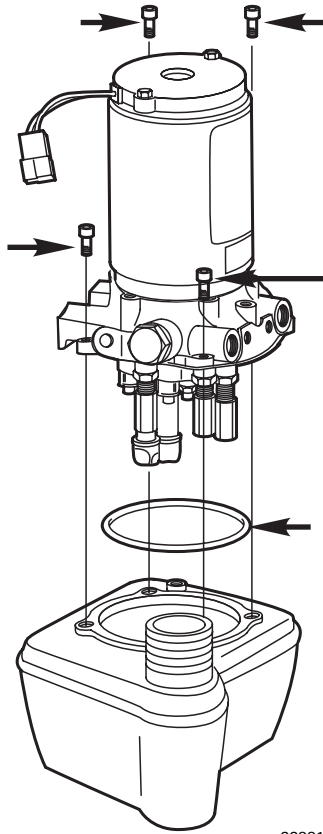
2. Place two O-rings onto screws and washers and insert screws through motor. Place the remaining two O-rings onto the screws.



3. Align the motor shaft with the two mounting screws. Install the motor onto the manifold and tighten screws to 40 in. lb. (5.4 N.m).



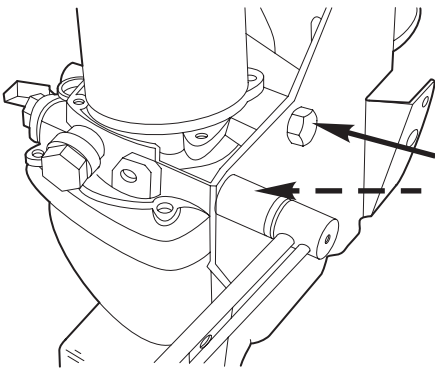
4. Coat a new O-ring with *Volvo Penta* Power Trim/ Tilt and Steering Fluid, or *Dexron* Automatic Transmission Fluid and place it on the manifold.



22881

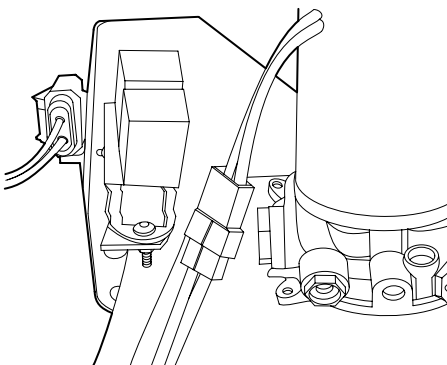
5. Align reservoir locating pin and manifold tab. Install reservoir and secure with four #6 allen head screws. Tighten screw to 20-25 in. lb. (2,2-2,8 N.m).

Installation of Pump Assembly



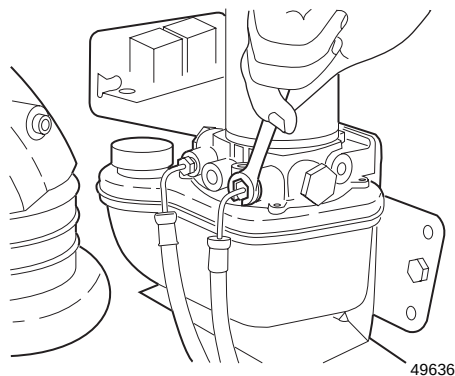
49654

1. Apply *Loctite Primer* to two trim/tilt assembly mounting screws and allow to air dry. Apply *Volvo Penta Thread Locking Fluid P/N 1161053* to the threads. Mount the trim/tilt pump assembly on the bracket and secure with the two screws. Tighten the screws to 120 in. lb. (13,6 N.m).



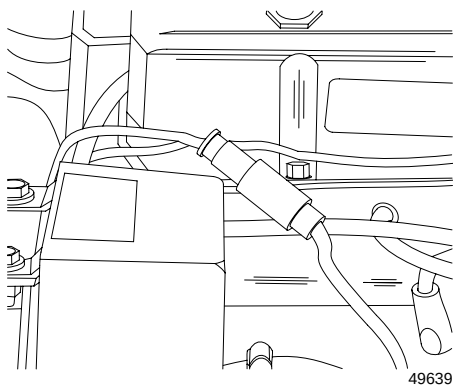
49653

2. Connect the trim/tilt motor to the wiring harness.
3. Attach trim/tilt unit to transom with two lag screws.

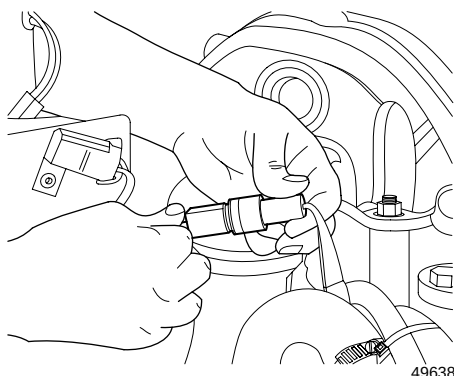


4. Connect tagged hydraulic line to "UP" port of the manifold. Connect remaining line to unmarked outlet. Tighten fittings to 84-108 in. lb. (9,5-12,2 N.m).

Tagged line must attach to correct opening. **If lines are switched, trim/tilt mechanism will not function properly.**



5. Connect the two wire pump power connector the engine wiring harness.



6. Connect the three wire pump connector to the instrument cable connector.
7. Fill trim/tilt system with hydraulic fluid and purge air following the procedure **See "Filling and Bleeding Dry System" on page 256.**

Servicing Trim/Tilt Cylinders

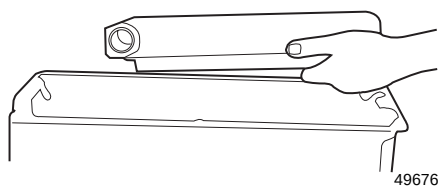
Disassembly

1. Follow the instructions in the respective **Transom Bracket** section of this service manual and remove the trim/tilt cylinders from the transom bracket.
2. Before disassembling trim/tilt cylinder, drain remaining fluid from it by extending and retracting rod.

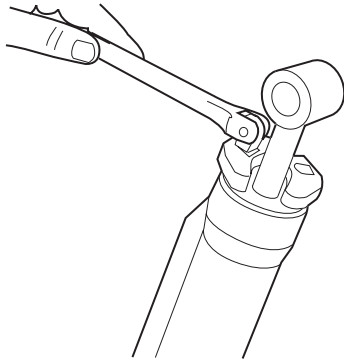


Warning!

Wear safety glasses. Turn cylinder ports down and place a container under both ports before piston is moved.

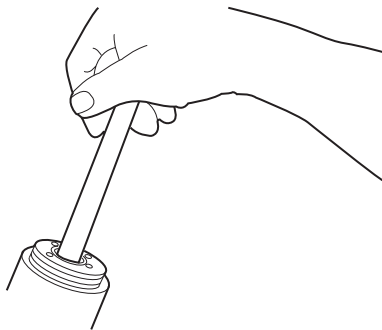


Hydraulic fluid expelled from cylinder can result in injury to you and others nearby.



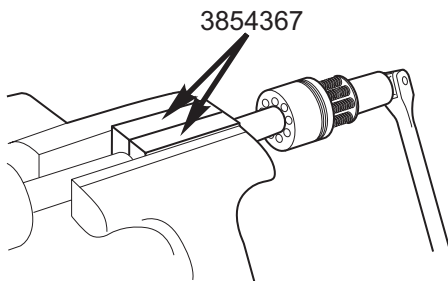
49677

3. Remove cylinder pivot bushings if they are to be replaced. To remove cylinder end cap, clamp cylinder in a soft-jaw vise. Using Spanner Wrench, *Volvo Penta* P/N 3854365, unscrew cap. A light tap with a mallet is often more effective than force to remove an end cap that is stuck.



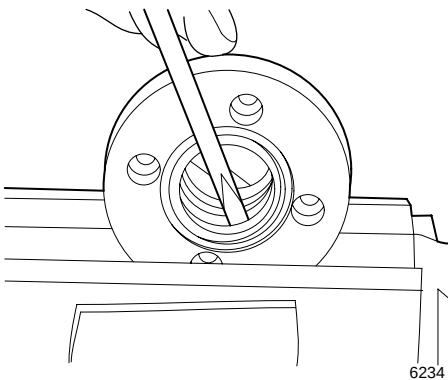
49678

4. Unscrew end cap until held by one thread, then extend rod. Piston is more easily withdrawn if end cap is left threaded one turn in cylinder until rod is fully extended. Unscrew end cap and remove piston.



49680

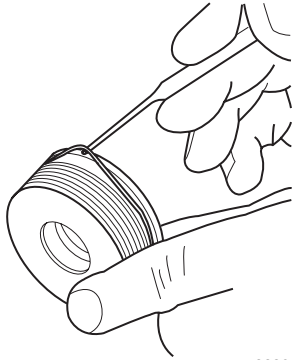
5. To replace internal O-ring and scraper in end cap, the piston must be removed from the rod. Thoroughly de-grease rod and holder. Clamp the piston rod assembly in a vise using Rod Holder, *Volvo Penta* P/N 3854367.
6. Remove piston by removing bolt that secures the piston to the rod. If rod slips in special tool, a piece of paper or thin card will increase grip on rod.



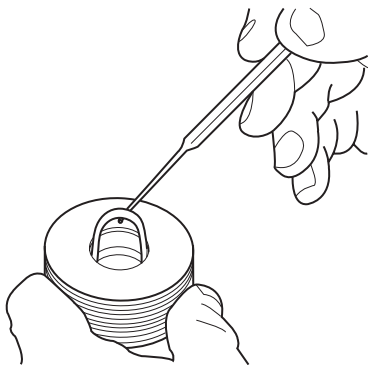
6234

7. Pull end cap off rod, then pry scraper out of end cap and discard.

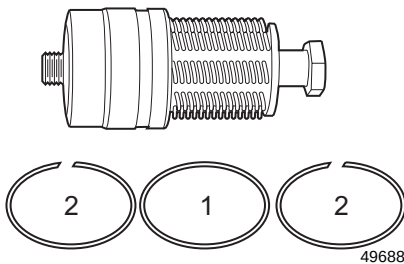
8. Remove both external and internal O-rings from end cap and discard.



13339



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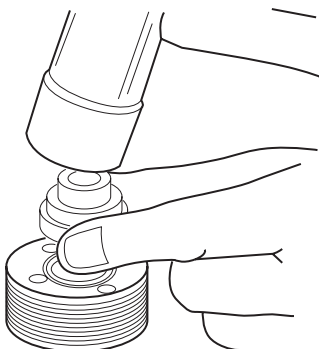
9. Carefully remove two split-ring retainers (2) and O-ring (1) from piston and discard. Do not remove or disassemble piston; there are no service parts.

Reassembly

1. Clean all hydraulic cylinder components in fresh solvent. Blow dry with compressed air. It is essential that all components are kept absolutely clean and dust free. Any dirt on internal components could cause scoring of the cylinder bore.

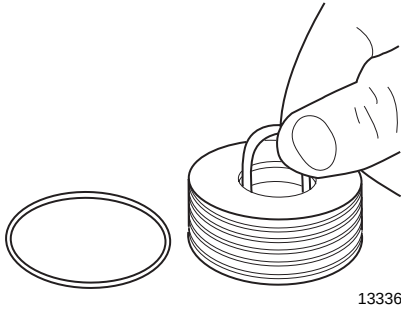
Note! Lubricate all internal components with *Volvo Penta Power Trim/Tilt & Steering Fluid* or *Dexron Automatic Transmission Fluid*.

2. Face scraper lip toward tool, and use Seal Installer, *Volvo Penta* P/N 3854364, or socket to install new scraper in end cap.

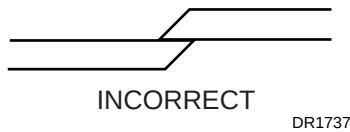
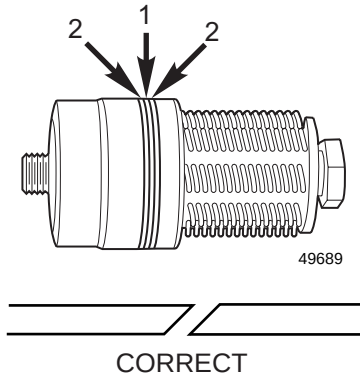


13333

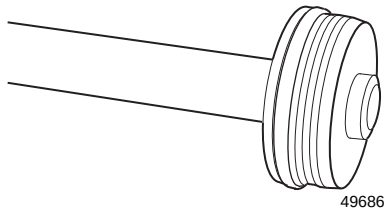
3. Insert a new O-ring inside end cap, and place a new O-ring around end cap. Lubricate O-rings with trim/tilt fluid.



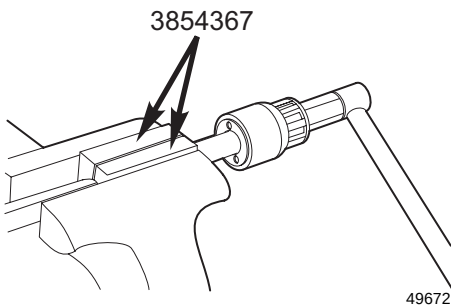
4. Place a new O-ring (1) on piston and lubricate it with trim/tilt fluid. Position split-ring retainers (2) on either side of O-ring making sure ends match as shown. The retainers are fragile and easily distorted or broken. Take care while installing them.

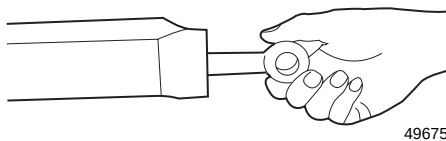
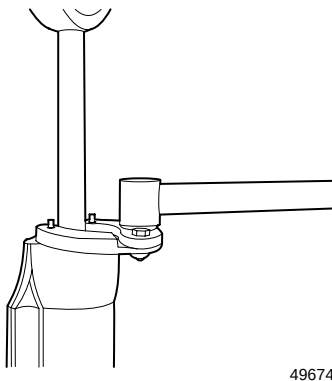
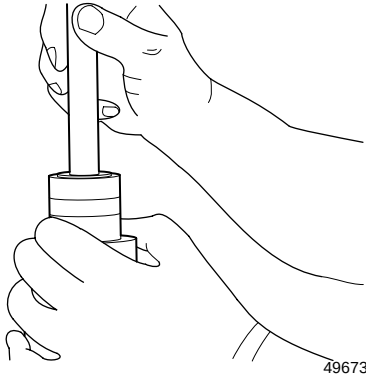


5. Lubricate internal O-ring, scraper, and piston rod. Slide end cap onto rod.



6. Clamp rod in a vise with Rod Holder, *Volvo Penta* P/N 3854367, or. Attach piston and rod, secure with bolt. Tighten bolt to 63-87 ft. lb. (85-118 N.m).





7. Clamp cylinder trunnion in soft-jaw vise. Lubricate cylinder bore, piston, and O-ring with trim fluid. Compress split-ring retainers with your fingers and push piston rod into cylinder bore.
8. Push piston rod all the way down into the cylinder. Fill the chamber with *Power Trim/Tilt & Steering Fluid* or *Dexron II Automatic Transmission Fluid*.
9. Thread end cap into cylinder and tighten using Spanner Wrench, P/N 912084. Tighten end cap to 25-30 ft. lb. (34-41 N.m). Rotate eyelet hole until it's parallel to trim/tilt rod hole in base of cylinder.
10. Attach trim/tilt cylinders to transom bracket following procedure in **Transom Bracket** section. Attach cylinders to sterndrive following procedure in **Sterndrive Removal and Installation** section.
11. Fill and bleed reservoir and trim system **See "Filling and Bleeding Dry System" on page 256.**

Filling and Bleeding Dry System

If trim components have been disassembled, or are known to be empty, follow this filling and bleeding procedure.

Trim Cylinders

1. Move trim rods to their fully retracted (down) position.
2. Unscrew cylinder end caps and fill the low-volume chambers with *Power Trim/Tilt & Steering Fluid* or *Dexron Automatic Transmission Fluid*. Install cylinder end caps and tighten to 25-30 ft. lb. (34-41 N.m).
3. Install trim cylinders and securely attach hydraulic lines.

Trim Motor and Reservoir

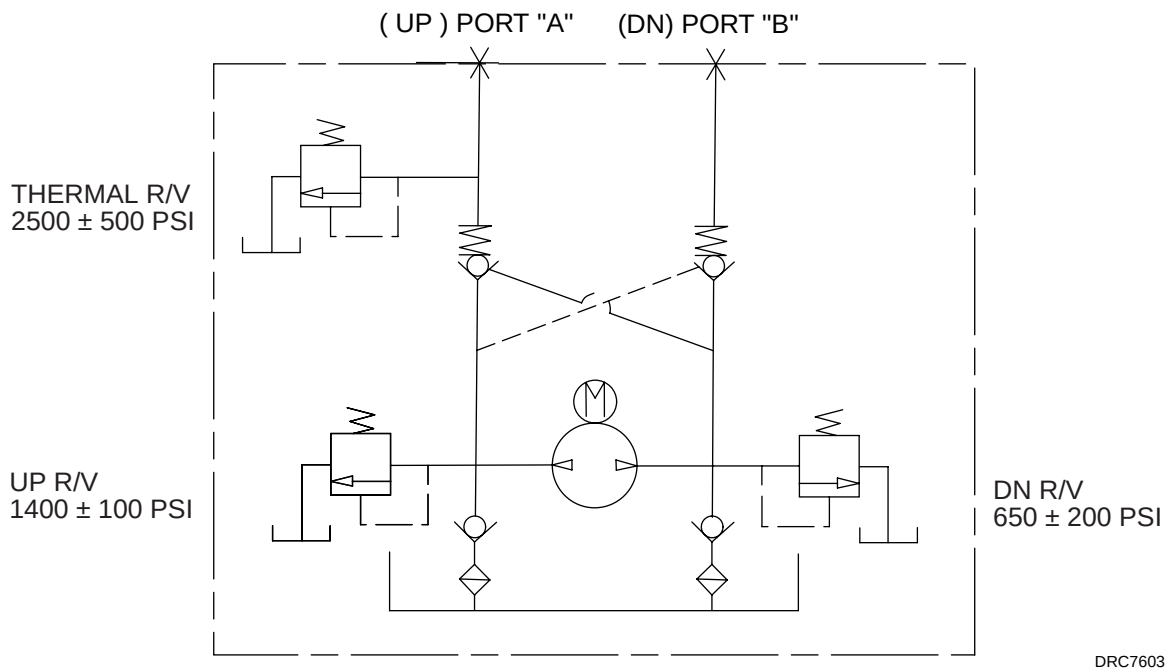
1. Mount motor and reservoir assembly on transom. Securely attach hydraulic trim lines.
2. Remove reservoir cap. Fill reservoir with *Power Trim/Tilt & Steering Fluid* or *Dexron Automatic Transmission Fluid* until level reaches the "MAX" line.
3. While continuing to fill reservoir, activate trim in "UP" direction. Make several stops as drive raises to give fluid time to stay close to the "MAX" line. Continue this fill-stop-fill sequence until trim rods are fully extended and drive is in full tilt position.
4. Add fluid until it's level with the "MAX" line, then install and tighten the cap.

5. Run drive through a minimum of five up and down cycles to purge air. Top off reservoir as necessary.

Hydraulic Pressure Specifications

Mode	Normal Pressure	Notes
Trim-out/tilt-up running	290-310 PSI (2000-2137 kPa)	24 amps max.
Tilt-up stall	1350-1450 PSI (9308-9998 kPa)	69 amps max.
Tilt-up stall/leak-down	100 PSI (690 kPa) maximum	5 minutes min.
Trim-in/tilt-down running	590-610 PSI (4068-4206 kPa)	36 amps max.
Trim-in stall	750-850 PSI (5171-5861 kPa)	44 amps max.
Trim-in stall/leak-down	1000 PSI (690 kPa) maximum	5 minutes min.
Impact Valve Opening	1800 PSI (12411 kPa) minimum	-

Hydraulic Flow Diagram



Notes

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting or typing. There are no margins, text, or other markings on the page.

Propellers

Table of Contents	Sealants, Lubricants and Adhesives	259
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Sealants, Lubricants and Adhesives

Volvo Penta Propeller Shaft Grease P/N 1141644

Safety Warnings

Before working on any part of this section, read the section called Safety at the end of this manual.

When replacement parts are required, use genuine *Volvo Penta Parts* or parts with equivalent characteristics including type, strength and material. Failure to do so may result in product malfunction and possible injury to the operator and/or passengers.

Proper installation is important for safe, reliable operation of all mechanical components. The procedures we recommend and describe in these instructions are effective methods to be followed when installing *Volvo Penta* stern drive products. Some of these methods require the use of tools specially designed for the purpose. The special tools should be used when and as recommended.

Special Tools

Table 1:

Tool Name	Volvo P/N	Panel Location
Front Propeller Remover/Installer	3855876-3	L

Propeller Selection - SX Models

Selecting the correct propeller for each engine/boat combination will ensure good engine service life and boat performance by permitting the engine to operate within the recommended RPM range. A propeller must be carefully selected to match the engine/boat combination, its intended application, and the anticipated load of the boat.

Note! Selection of the wrong propeller will reduce engine service life, affect boat performance, and may cause serious engine damage.

It is important to remember that propeller pitch and diameter determine engine RPM at full throttle. To determine the propeller best suited for

each application, use a tachometer of known accuracy to check engine RPM. The propeller which allows the engine to obtain the maximum percentage of available horsepower, and run near the **top limit** of its **full throttle operating range** with the lightest load the boat will carry, is suited for your application. In most cases, selecting a propeller in this manner will prevent the maximum RPM dropping below the low limit of the operating range when the boat has a maximum load.

There are instances when the propeller selected cannot cover the complete range of boat applications, for example, from water skiing to high speed performance. In such cases, it may be necessary to change propellers to suit each particular situation.

- Propeller prevents engine RPM from attaining the specified "Full Throttle Operating Range." Engine is laboring, install lower pitch propeller.
- Propeller allows engine RPM above the specified "Full Throttle Operating Range." Engine is overspeeding, install higher pitch propeller.

Remember, if the engine operates below the recommended full throttle RPM range, the engine is laboring and power and efficiency are being lost. If the engine operates above the recommended full throttle RPM range, engine speed is excessive and additional power and efficiency are not being gained. In either case, serious engine damage may result.

Note! Changing propellers on some SX models covered in this manual may require readjusting the trim tab on stern-drives so equipped.

Propeller Removal and Installation - SX Models

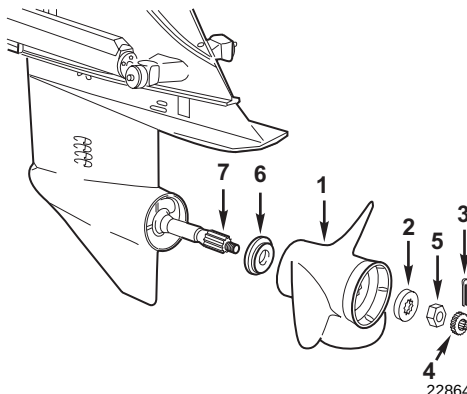
A rubber hub in the propeller is the shock absorber that minimizes damage to the sterndrive and engine. If the rubber hub should begin to slip, it should be replaced. This can be safely done by any reputable propeller repair shop. Only genuine *Volvo Penta Parts* should be used to rebuild the propeller.



Warning!

To avoid accidental starting of engine, be sure remote control is in NEUTRAL position and ignition key is removed. Protect your hands from sharp edges of propeller blades by wearing gloves when removing or installing the propeller.

Removal



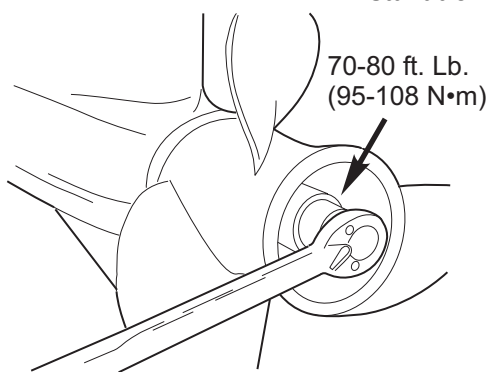
1. Ignition switch must be **OFF**.
2. Make sure the remote control is in **NEUTRAL**.
3. Remove the cotter pin (3) and keeper (4).
4. Shift the remote control into **FORWARD** to lock the propeller shaft.
5. Remove the propeller nut (5) using a 1-1/16 wrench.
6. Remove the thrust washer (2), propeller (1), and thrust bushing (6).
7. Wipe the propeller shaft (7) clean. Inspect for fishing line; remove if present.

Installation



CAUTION!

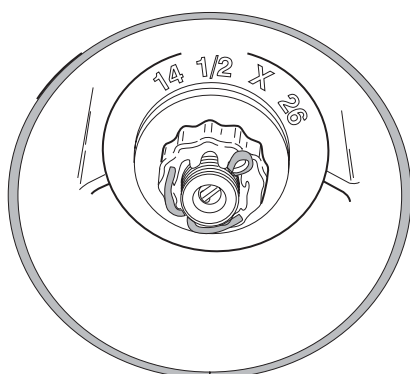
Failure to install all components could result in loss of propeller and damage to drive unit next time the boat is operated.



6604

1. Ignition switch must be **OFF**.
2. Make sure the remote control is in **NEUTRAL**.
3. Coat the full length of the propeller shaft (7) and the inside of the propeller hub with *Volvo Penta propeller shaft grease* P/N 1141644; removal of the propeller will be difficult if this is not done.
4. Place the thrust bushing (6) on the propeller shaft with the inner taper toward the gearcase to match the taper on the propeller shaft.
5. Install the propeller (1) onto the propeller shaft, aligning splines, and push the propeller onto the thrust bushing until the splines are exposed.
6. Install thrust washer (2) on propeller shaft splines.
7. Shift the remote control into **REVERSE** gear to lock the propeller shaft.
8. Install and tighten the propeller nut (5) to **70-80 ft. lb. (95-108 N•m)**.
9. Index the keeper on the propeller nut until it is aligned with the cotter pin hole.
10. Install the cotter pin and bend the ends to secure; use a new cotter pin if necessary.
11. Shift the remote control into **NEUTRAL**.

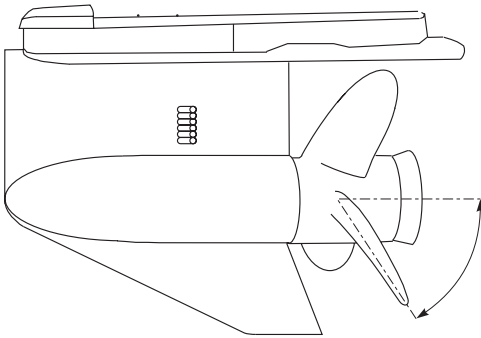
Note! Propeller should turn freely. Propeller spacer, nut, keeper and cotter pin must be installed as shown. Failure to install all components could result in loss of the propeller when boat is operated in **REVERSE**.



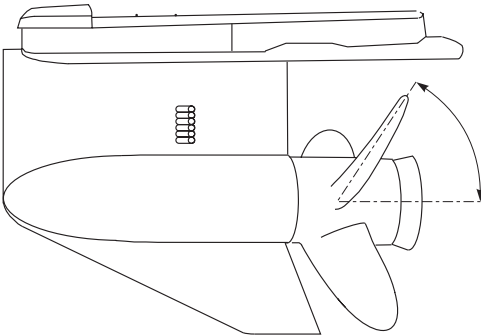
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Left-Hand Rotation - SX Models

All SX models covered in this manual have a sterndrive capable of both right and left-hand rotation. Left-hand rotation is accomplished in the remote control. Refer to the installation instructions of the remote control for this information. The propeller, propeller shaft and vertical driveshaft are the only parts that rotate to the left. The engine always rotates to the right.



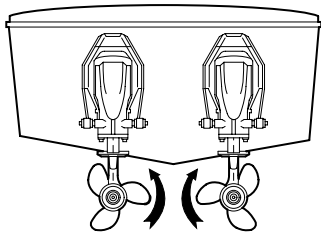
Right-hand rotation propellers rotate clockwise (as viewed from the rear of the boat) to propel a boat forward. Right-hand propellers are considered standard rotation propellers. To identify a right-hand rotation propeller, note the angle of the blade as viewed from the port side. This propeller is used on single engine boats or on the starboard engine of a twin engine boat.



Left-hand rotation propellers rotate counterclockwise (as viewed from the rear of the boat) to propel a boat forward. Left-hand propellers are considered counter-rotation propellers. To identify a left-hand rotation propeller, note the angle of the blade as viewed from the port side. This propeller is used **ONLY** on the port engine of a twin engine boat.



Never interchange a right-hand rotation propeller with a left-hand rotation propeller. This would result in the boat being propelled in reverse when the motors are operated in forward gear, and forward when the engines are operated in reverse gear.



After having the propellers remote control or shift cables serviced, shift into **FORWARD** or **REVERSE** at idle speed to determine if the boat moves in the direction indicated by the position of the control handle. If the boat moves **OPPOSITE** the direction indicated by control handle, check for correct propeller, and check installation and adjustment of the remote control and shift cables.



Failure to perform the above test could result in loss of boat control.

Propeller Selection - DP-S

The selection of propellers is essential for obtaining the best performance from a boat equipped with a DP-S sterndrive. *Volvo Penta* offers a selection of twin propeller sizes for use with the DP-S product line. Propellers are available in both aluminum and stainless steel. Restriction on the use of specific propellers sometimes apply.

DP-S propellers are coded "D" for aluminum propellers and "F" for stainless steel. A number follows the letter. As the number increases, the pitch increases. The opposite is also true, as the number decreases so does the pitch. The sets of propellers have been factory matched to provide optimum performance on a given engine sterndrive combination. The propellers are sold as sets and must not be mixed.

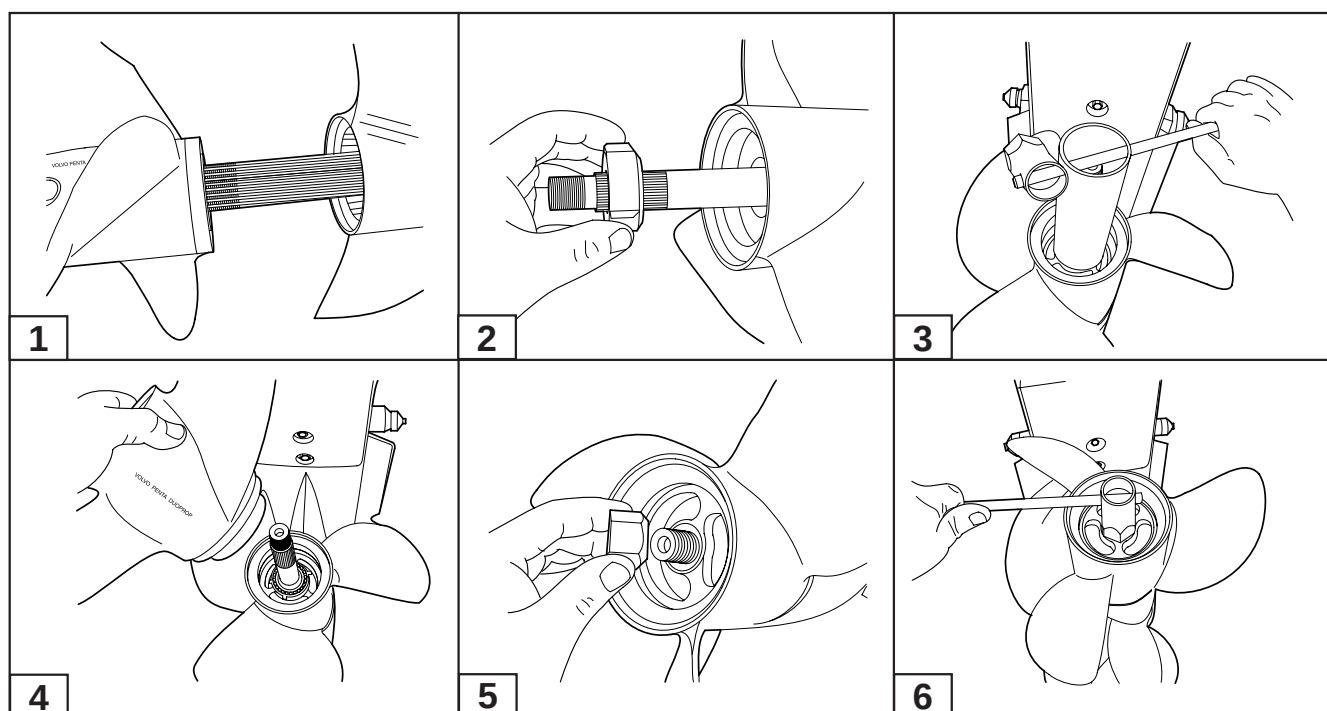
Actual on-water testing of the boat is recommended as the only way to accurately determine the best engine and propeller combination.

When choosing a set of propellers, it is sometimes difficult to select a size that returns the rated RPM of the engine under varying conditions of sea and load. As a rule of thumb, the boat that is heavier and more difficult to push through the water should use a propeller set with a smaller pitch number. This type of boat may benefit by operation at the lower end of the rated RPM range. The opposite is true for light fast boats with refined hulls, in that a higher pitch propeller operating at the maximum rated RPM may be the best choice.

Note! If a propeller set does not allow the engine RPM to fall in the desired range, select to next set either one number higher to decrease RPM, or one number lower to increase RPM. A change in propeller set number should change the engine RPM about 200 to 250 RPM.

Many factors influence the way a propeller set functions; hull shape, load, engine output, range of use, etc. Practical tests are the best way of determining whether the correct propeller set has been selected. Regardless of the full throttle speed which has been obtained, the best overall economy will be achieved with a cruising speed about 15% to 25% below the maximum speed obtained.

Propeller Removal and Installation - DP-S Models



To avoid accidental starting of engine, be sure remote control is in NEUTRAL position and ignition key is removed. Protect your hands from sharp edges of propeller blades by wearing gloves when removing or installing the propellers.

- Removal**
1. Move the shift control to **FORWARD**. Remove the rear propeller nut using a 30 mm socket. Remove the rear propeller from the shaft. Check for fish line and remove if found.
 2. Move the shift control to **REVERSE**. Remove the front propeller nut using Front Propeller Tool, Volvo Penta P/N 3855876.

Remove the front propeller from the shaft. Check for fish line and remove if found.

3. Wipe both propeller shafts clean and check for damage. Repair any damage.

Installation

1. Coat the full length of both propeller shafts with *Volvo Penta Propeller Shaft Grease* P/N 1141644.
2. Place the remote control in the **FORWARD** gear position to lock the propeller shafts.
3. Install the front propeller. Install the front propeller nut and tighten to 45 ft. lb. (60 N.m) using Front Propeller Tool, *Volvo Penta* P/N 3855876.
4. Place the remote control in the **REVERSE** gear position to lock the propeller shafts.
5. Install the rear propeller. Install the rear propeller nut and tighten to 50 ft. lb. (70 N.m).

Note! Failure to install the propellers as indicated could result in the loss of the rear propeller and damage to the drive unit when the boat is operated.

Condition of Boat Bottom

The condition of the boat bottom affects the boat's performance considerably. Marine growth (slime, barnacles, or other foreign matter), which will accumulate in fresh or salt water, will cut down on performance and speed. The boat bottom should be cleaned periodically in accordance with manufacturer's recommendations.

Bottom Painting

If your boat is in water where marine growth is a problem, the use of an anti-fouling paint will reduce the growth rate. See your dealer for an anti-fouling paint that is suitable for your area.

- Tin base anti-fouling paint (TBTA or TBTF*) is recommended where its use is permitted.
- Copper base anti-fouling paint may be used, but will require more frequent inspection and replacement of sacrificial anodes. DO NOT PAINT any part of the vertical drive with copper base anti-fouling paint.

* Tributyl Tin Adipate or Tributyl Tin Fluoride

Note! Painting the sterndrive with copper base paint will accelerate galvanic corrosion.

- Vinyl-butyl base anti-fouling paint is a recommended alternative.
- DO NOT USE any graphite base anti-fouling paint.

Note! Never paint anti-corrosion anodes, or their effectiveness will be lost.

See the *Volvo Penta Parts* Catalog for anode kits that provide further corrosion protection for the sterndrive assembly.

Boat Trailers

It is extremely important that the trailer fits the boat properly. Loss of boat performance and speed may be due to improper trailer support and excessive tie-down pressure which has caused the boat bottom to hook. The boat should rest firmly on the trailer with maximum tie-down pressure applied at the bow and transom only.

Boat Trim - SX and DP-S

The power trim/tilt system allows for trimming the sterndrive in or out to compensate for a major change in boat loading and weight distribution.

DP-S sterndrives should limit trim to $\pm 5^\circ$. Serious propeller and vertical drive damage can occur if the sterndrive is operated at trim angle that is too high or low.

Propeller Hub Replacement

A rubber hub in the propeller is the shock absorber which minimizes the chance of damaging the propeller, lower gearcase, or drive train components during shifting or striking an underwater object. If the hub should become damaged and slip, it can be replaced by an authorized service dealer or propeller station.

High Altitude Operation

A performance loss at altitudes above 3500 ft. can be expected. If you are boating above 3500 ft. elevation for a short term, a lower pitch propeller will restore some of the lost performance. Long term use above altitudes of 3500 ft. may require a change in gear ratio. Contact your dealer regarding installation of a high altitude gear set.

To avoid permanent engine damage, be sure that a boat modified for high altitude operation is properly identified. Return it to its original gear ratio if operated for prolonged periods at or near sea level.

Notes

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting or typing. There are no margins, text, or other markings on the page.

